Perryville, Missouri
Water Supply Study
Saline Creek

INTRODUCTION:

This analysis was made to assess the availability of Perryville's water supply. Perryville obtains their water supply from two sources, Saline Creek and three wells. In year 2000, demand used a total 414,459,000 gallons from both sources, 289,448,000 gallons from Saline Creek and 125,011,000 gallons from the wells. This report addresses the stream flow in Saline creek.

DISCUSSION:

Perryville has no off channel storage to draw upon during periods of low flow, they would need to rely on their 3 wells. The drainage area at the creek intake for Perryville is 55.83 square miles. In the year 2000 Perryville used 1.14 MGD, 0.79 from Saline Creek and 0.34 from wells. The intake is located at the Southwest side of Perryville. It would be necessary to continuously pump 550 gpm to obtain 0.79 MGD from Saline Creek.

There is no stream gage on Saline Creek. Two stream gages on St. Francis River were correlated and results found to be nearly equal when adjusted to a per square mile basis. These gages are the long-term gage on St. Francis River at Patterson, drainage area of 370.45 square miles, and Little St. Francis River at Fredericktown, drainage area of 90.5 square miles. The upper reaches of Little St. Francis River border the drainage area of Saline Creek. Adjustments to runoff for Saline Creek were made based on drainage area. **Figure 50.1** shows the annual rainfall at Perryville for the period 1950 through 2001. This indicates the precipitation trend to be nearly uniform for the period of record with the trend averaging about 41 inches annually. **Figure 50.2.a** shows the annual runoff for Saline Creek at the intake point. The trend indicates runoff to be nearly uniform for the period of 1950 to year 2000. **Figure 50.2.b** shows the runoff in terms of mean annual cubic feet per second.

Stream gage records show the drought of record to be in the 1950's. The following **figures 50.3.a, 50.3.b, 50.3.c, 50.3.d, 50.3.e, and 50.3.f** compare the 1-%, 2% and 4% chance mean monthly non-exceedence flows (low flow) to measured flows for 1952, 1953, 1954, 1955, 1956 and 1957. All frequencies exceeded or equaled the adjusted 7-day Q-10 discharges in 1952, 1954, and 1957. September mean flows tended to be the lowest in all years. In 1953, 1955, and 1956 the flows were very low and equaled the 7-day Q-10 low flow needed to meet in-stream flow requirements.

Base flow separation was made using the USGS computer program, HYSEP. HYSEP separates the base flow hydrograph from the total hydrograph. This analysis was made to estimate sustained flow for meeting water supply needs during a drought. **Figure 50.4.a** is the base flow index and is the ratio of base flow to total stream flow. This chart shows the yearly fluctuation in base flow indexes and indicates the trend. The trend shows the base flow index increasing from about 46% to 53% during the period of 1950 through 2000. Base flow was calculated and is shown in **figure 50.4.b** in terms of cfs for the period of 1950 through 2000. Trend shows that mean base flow has increased from about 29 cfs to approximately 33 cfs for that period. Total flow was also calculated and is shown in **figure 50.4.c**. The trend for mean total flow has increased from 45 cfs to 53 cfs for the 50-year period.

Because Saline Creek has no stream gage to make flow analysis it was necessary to compare flow data at several gages for their period of record. Gages chosen were the long term gage on St. Francis River at Patterson, Little St. Francis River at Fredericktown having a period of record 1986 through 1998, and Little Black River near Annapolis. The results

are on a runoff per square mile basis and show nearly like results. They are shown in **figures 50.4.d and 50.4.e**.

To determine the rate of flow needed to maintain in-stream flow requirements, the 7-day Q-10 low flow was determined using the period of record, 1950 through 2000. The computer program named 'DURFREK' (a duration frequency computer program developed by Hydrosphere) was used to determine discharge values. **Figure 50.5.a** shows the plot of the values for a frequency analysis. The 7-day Q-10 frequency analysis was determined to be 1.0 cfs. Seven-day annual low flows for 1950 through 2000 were calculated and are shown **figure 50.6**. Visual observation shows that the trend for 7-day annual low flows is nearly constant for the 50 years between 1950 and 2000.

Monthly non-exceedence probabilities (low flows) for 1% chance of occurrence (1 time in 100 years), 2% chance (1 time in 50 years) and 4% chance (1 time in 25 years) were established from stream flow data for the years 1950 through 2000. **Figure 50.7** displays these results. Mean monthly low flow probabilities exceed the 7-day Q-10 discharge of 1.0 cfs for all frequencies except for August and September when mean flows are approximately equal to the 7-day Q-10 flow. The 1% chance low flow is slightly less than 7-day Q-10 in these months. For this report, all statistical determinations were made using the Log Pearson type 3 method as described in Water Resource Council bulletin 17B. **Figures 50.8a, 50.8b, and 50.8c** show the mean deficits in stream flow for the 1%, 2% and 4% chance of low flow being discharge needed to allow for pumping and maintain the 7-day Q-10 low flow. For the 1% chance low flows, every month has a chance of not meeting flow requirements. The 2% chance shows that the months of February, March, April and May have potential of meeting demands. For the 4% chance low flows there are four months that have the potential of not meeting needs. These months are August, September, October and November.

Figure 50.9 is the daily demand by Perryville, in million gallons per year. During the period of 1994 through 2001 their demand has been constant at approximately 1.1 MGD.

Additional comparisons for the 1950's drought were made using the mean 7-day low flow for examining a shorter duration. These comparisons are shown in **figures 50.10.a, 50.10.b, 50.10.c and 50.10.d**. These figures compare mean seven-day low flows to 7 day Q10 flow, and indicate short-term critical periods. In the 4 years period of 1953 through 1956 there were 12 months that had mean seven-day flows below 7 day Q10 discharge.

Conclusion:

In year 2000 the city used a total of 414,459,000 gallons of which 289,448,000 gallons came from Saline Creek, resulting in a mean annual withdraw of 1.14 MGD.

The probability of adequate stream flow in Saline Creek during the months of August, September and October is very low. To meet the mean daily demand from the creek of 1.22 cfs plus the in-stream flow requirement of 1 cfs, at least 2.22 cfs would need to be flowing in the stream before pumping. Every month of the year has the possibility of having the 1% chance low flow below that which would allow pumping from the stream. For the 2% chance of occurrence, only the spring months of February, March, April and May could be expected to have mean flows of sufficient quantity to allow pumping. During the months of August, September and October, Saline Creek could not be depended upon to allow pumping, even at the 4% chance low flow range.

Perryville's water demand has remained nearly constant for the period 1994 through 2001.

Perryville, Missouri

Water Supply Study

Annual Rainfall

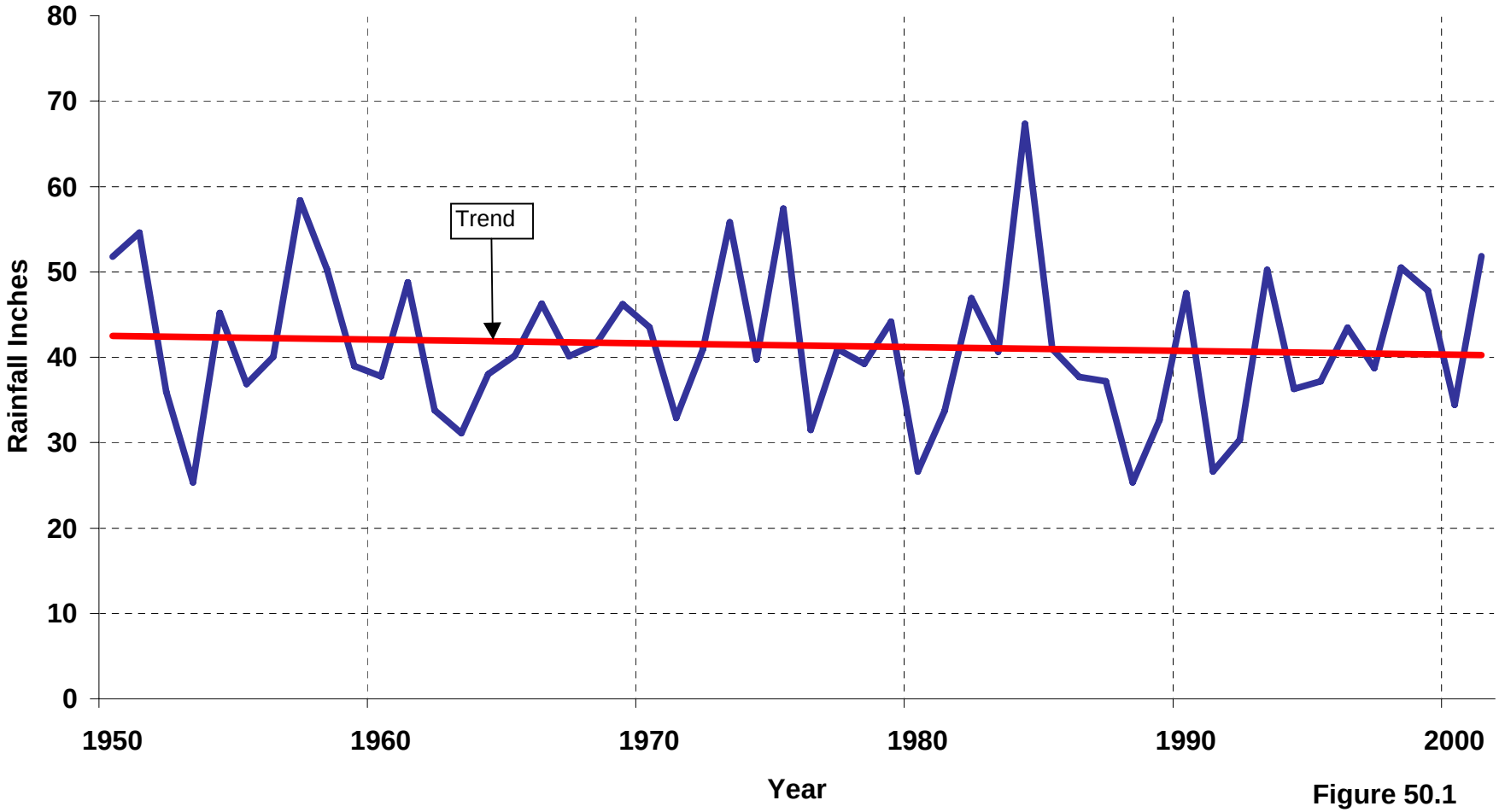


Figure 50.1

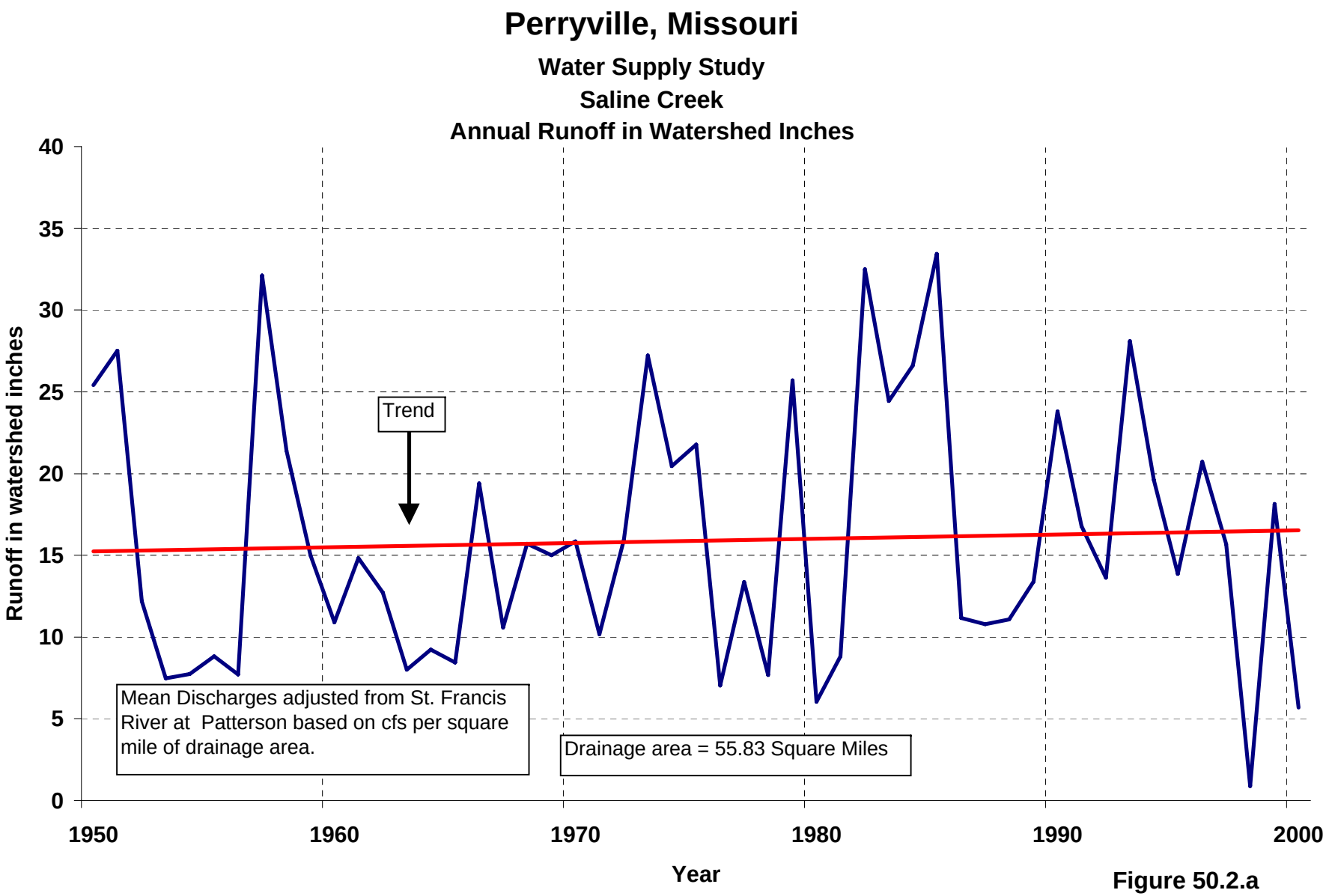

Perryville, Missouri
Water Supply Study
Saline Creek
Annual Runoff in Watershed Inches
Runoff in watershed inches
40
35
30
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
Year
Trend
Mean Discharges adjusted from St. Francis River at Patterson based on cfs per square mile of drainage area.
Drainage area = 55.83 Square Miles

Figure 50.2.a

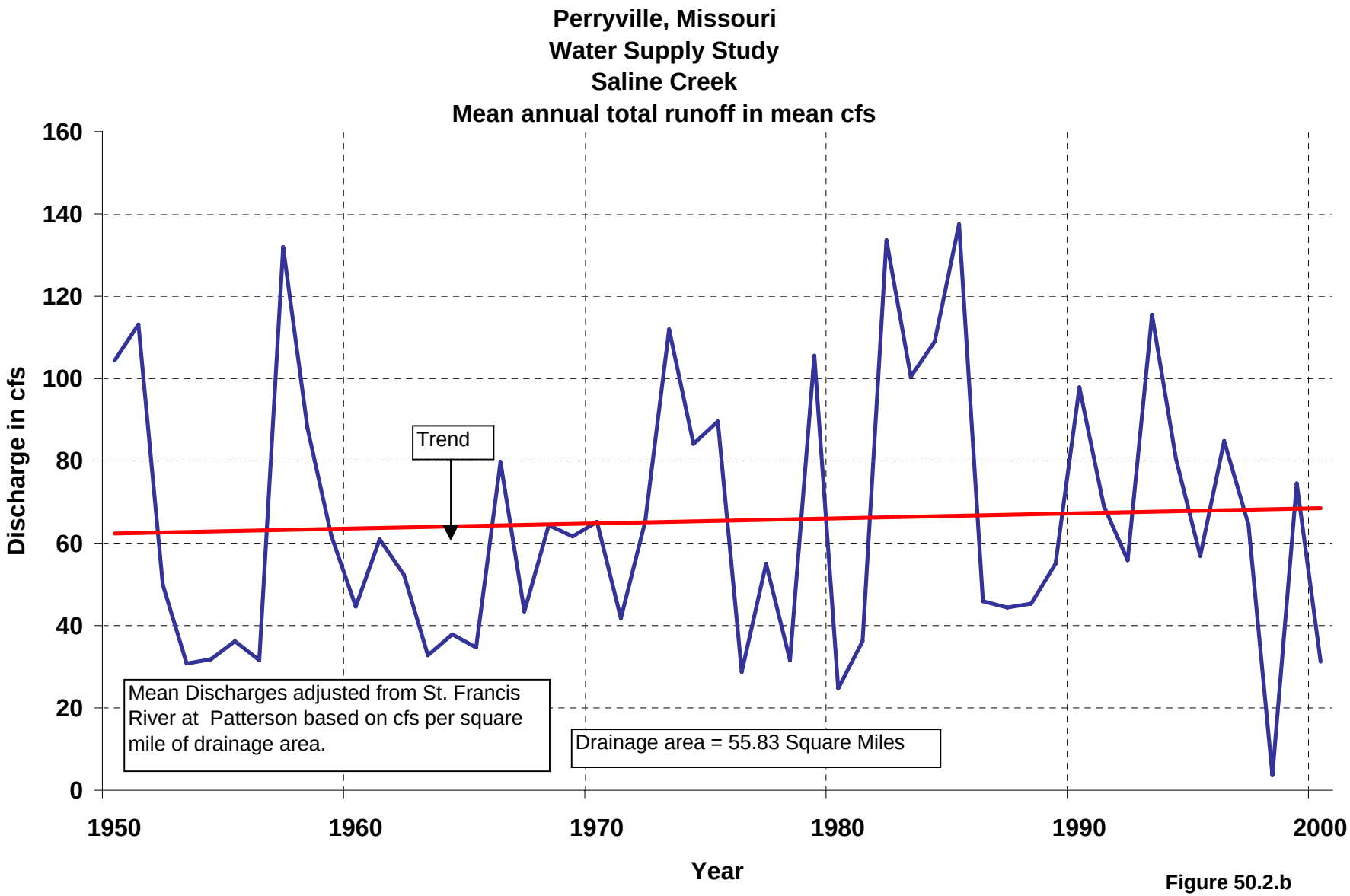

Perryville, Missouri
Water Supply Study
Saline Creek
Mean annual total runoff in mean cfs
Discharge in cfs
160
140
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
Year
Trend
Mean Discharges adjusted from St. Francis River at Patterson based on cfs per square mile of drainage area.
Drainage area = 55.83 Square Miles

Figure 50.2.b

Perryville, Missouri

Water Supply Study

Saline Creek

Compare mean non-exceedent flows to 1952 Values

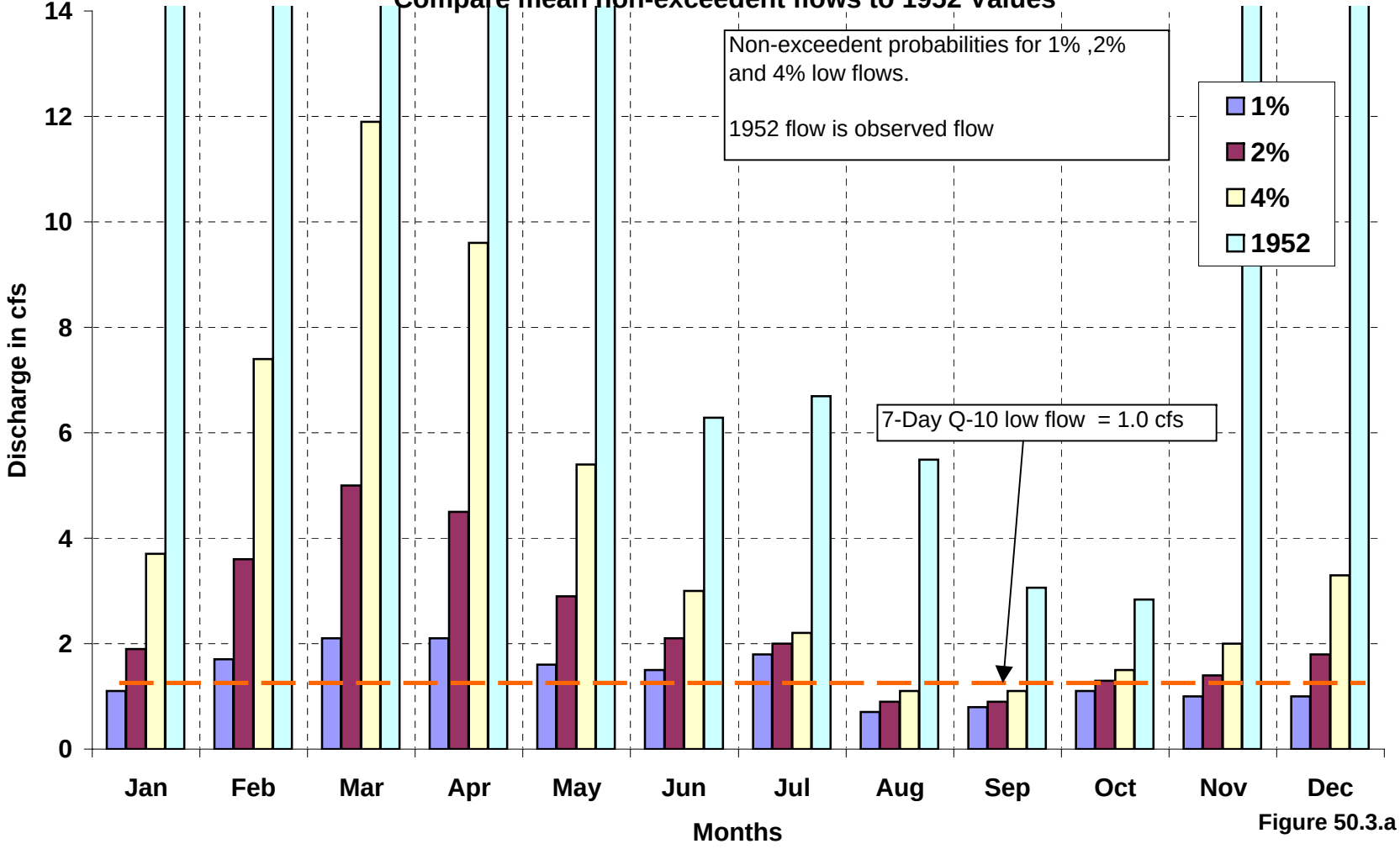


Figure 50.3.a

Perryville, Missouri

Water Supply Study

Saline Creek

Compare Mean non-exceedent flows to 1953 values

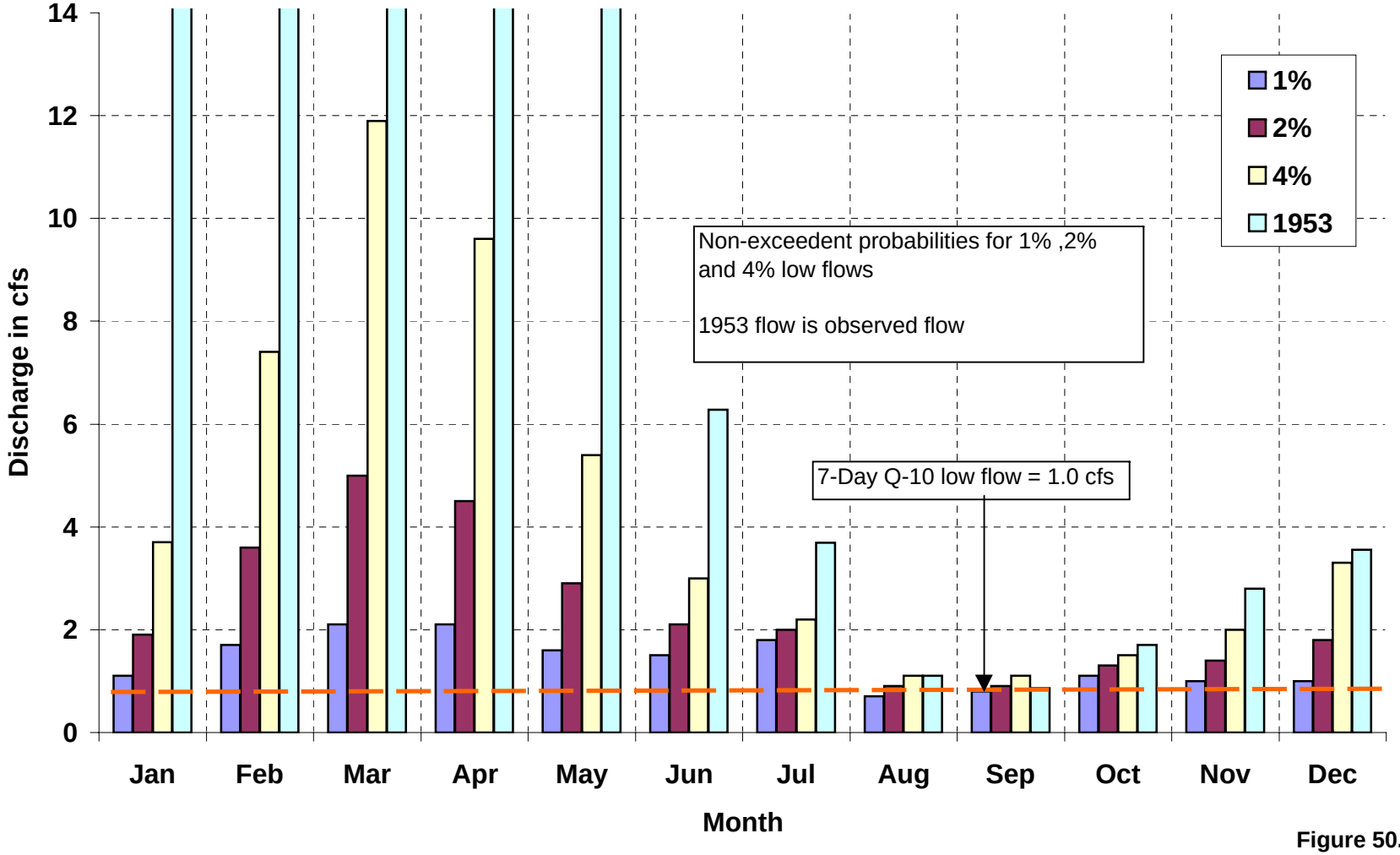


Figure 50.3.b

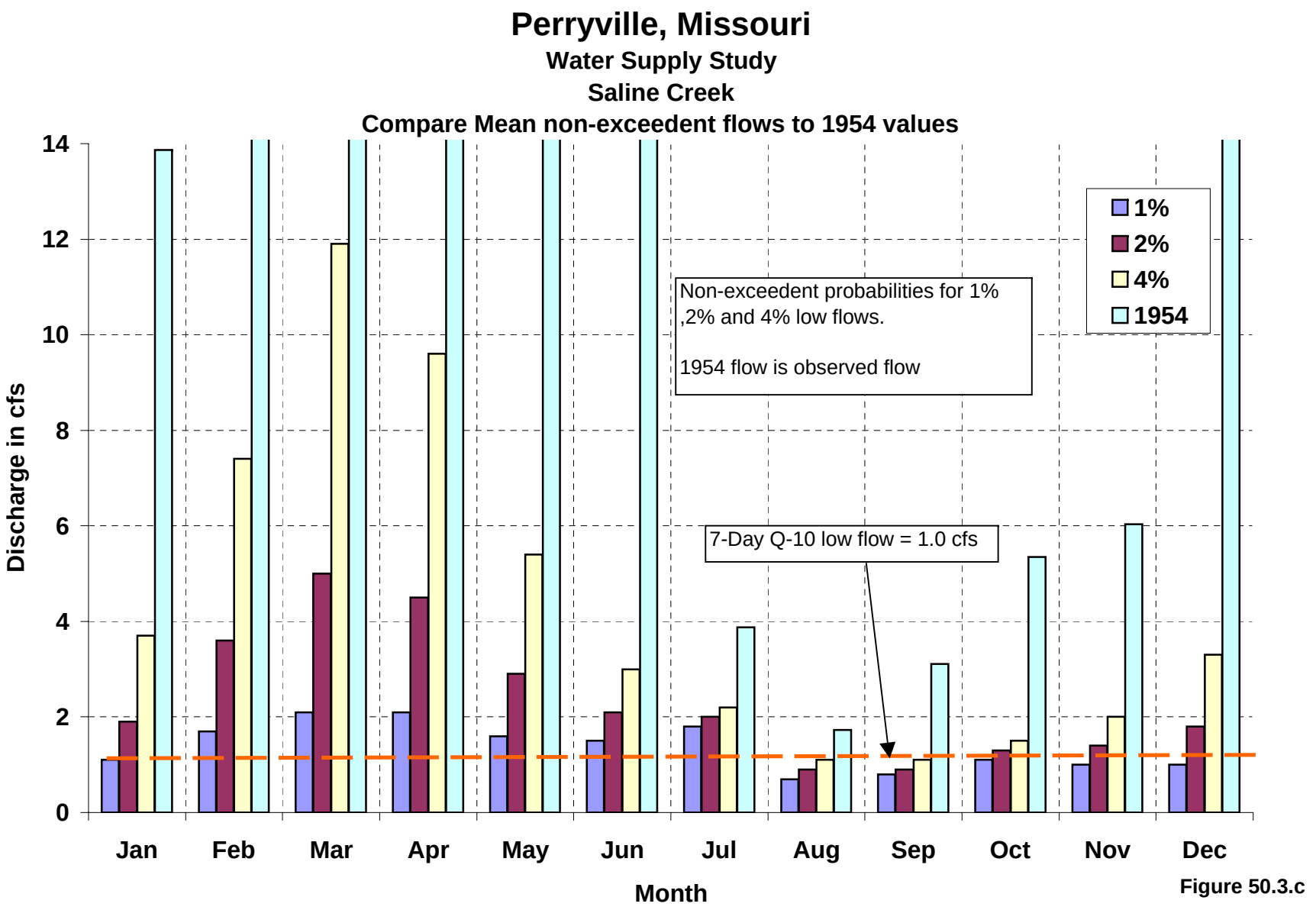

Perryville, Missouri
Water Supply Study
Saline Creek
Compare Mean non-exceedent flows to 1954 values
Discharge in cfs
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1%
2%
4%
1954
Non-exceedent probabilities for 1% ,2% and 4% low flows.
1954 flow is observed flow
7-Day Q-10 low flow = 1.0 cfs

Figure 50.3.c

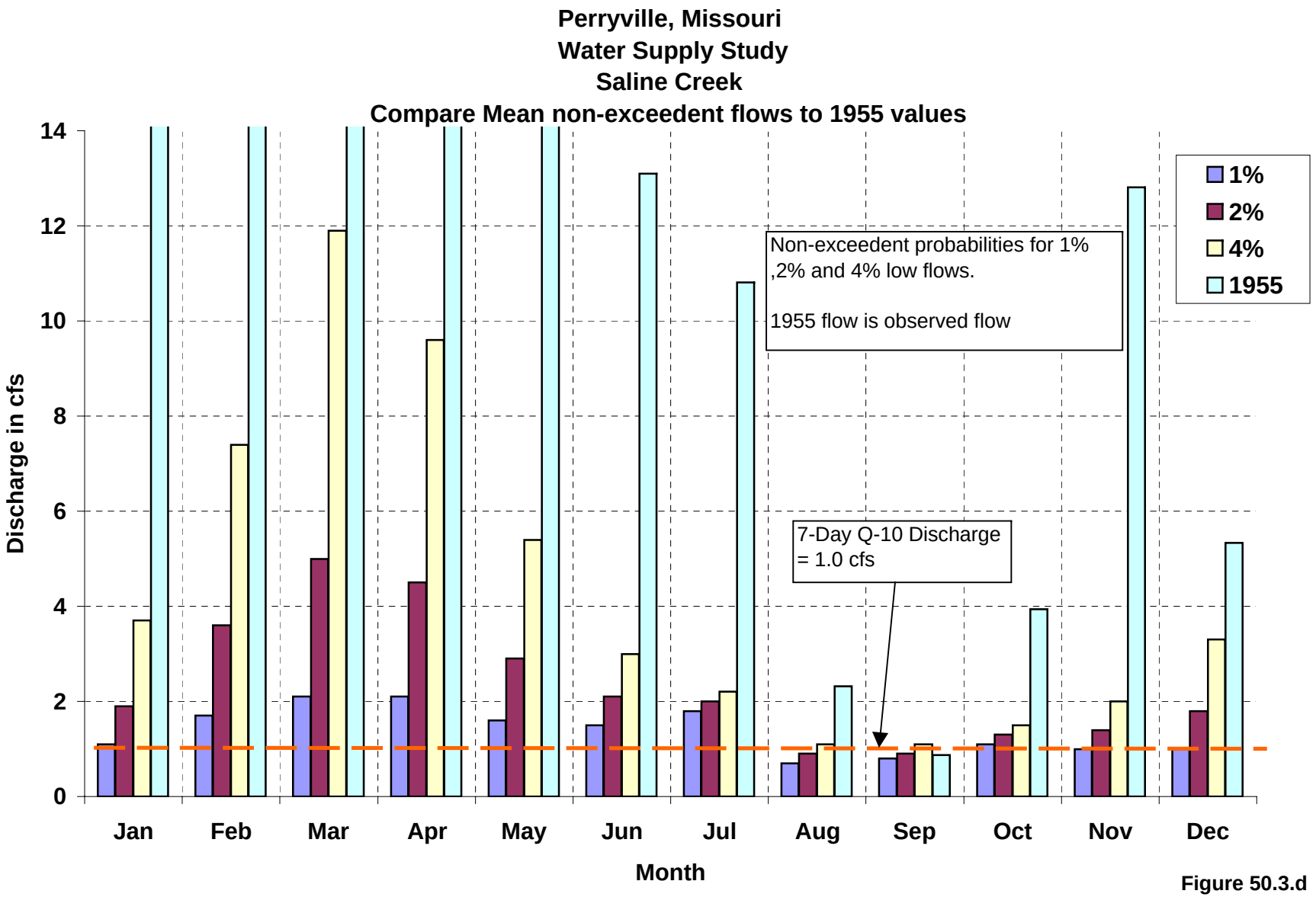

Perryville, Missouri
Water Supply Study
Saline Creek
Compare Mean non-exceedent flows to 1955 values
Discharge in cfs
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1%
2%
4%
1955
Non-exceedent probabilities for 1% ,2% and 4% low flows.
1955 flow is observed flow
7-Day Q-10 Discharge = 1.0 cfs

Figure 50.3.d

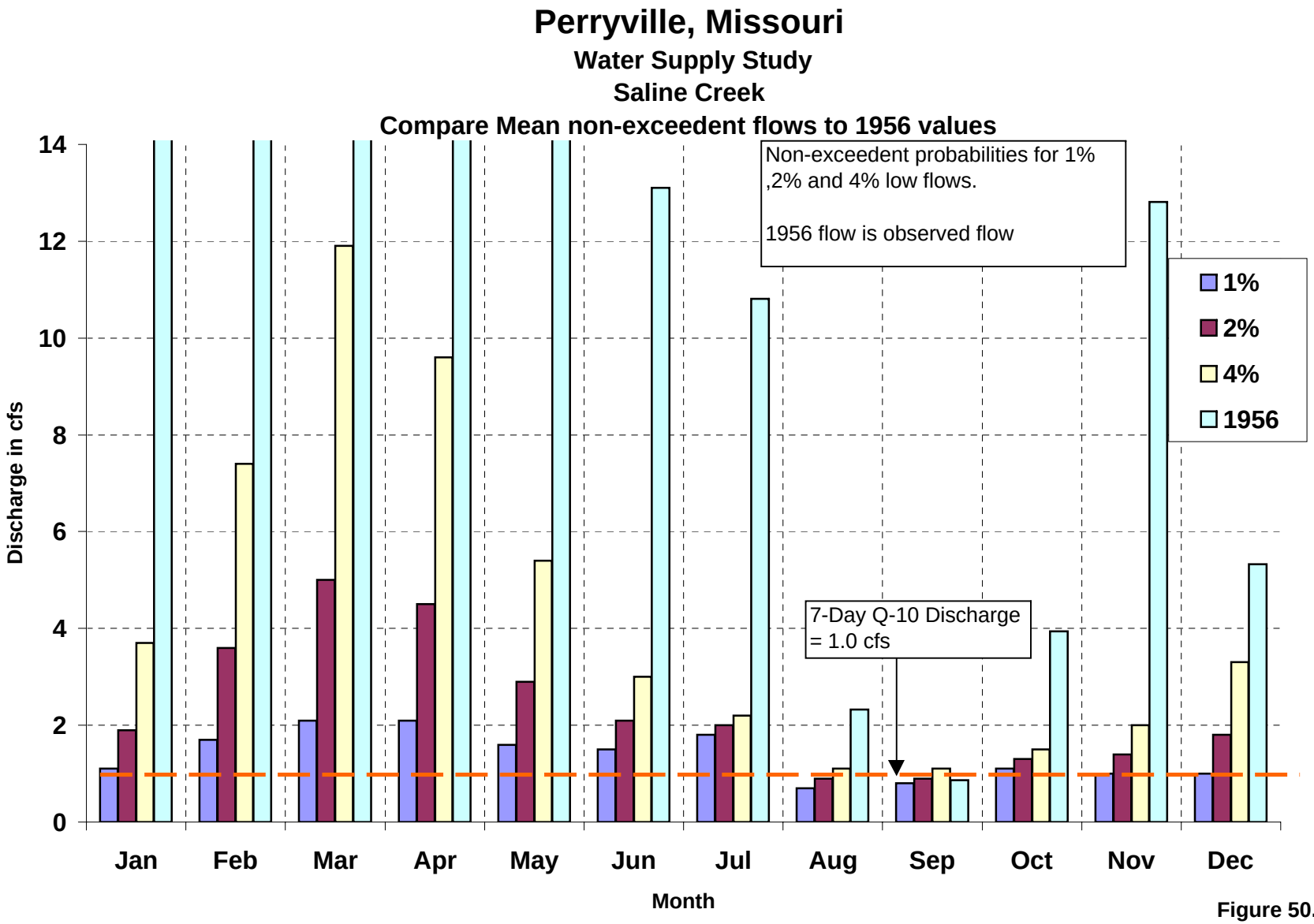

Perryville, Missouri
Water Supply Study
Saline Creek
Compare Mean non-exceedent flows to 1956 values
Non-exceedent probabilities for 1% ,2% and 4% low flows.
1956 flow is observed flow
7-Day Q-10 Discharge = 1.0 cfs
1%
2%
4%
1956
Discharge in cfs
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Figure 50.3.e

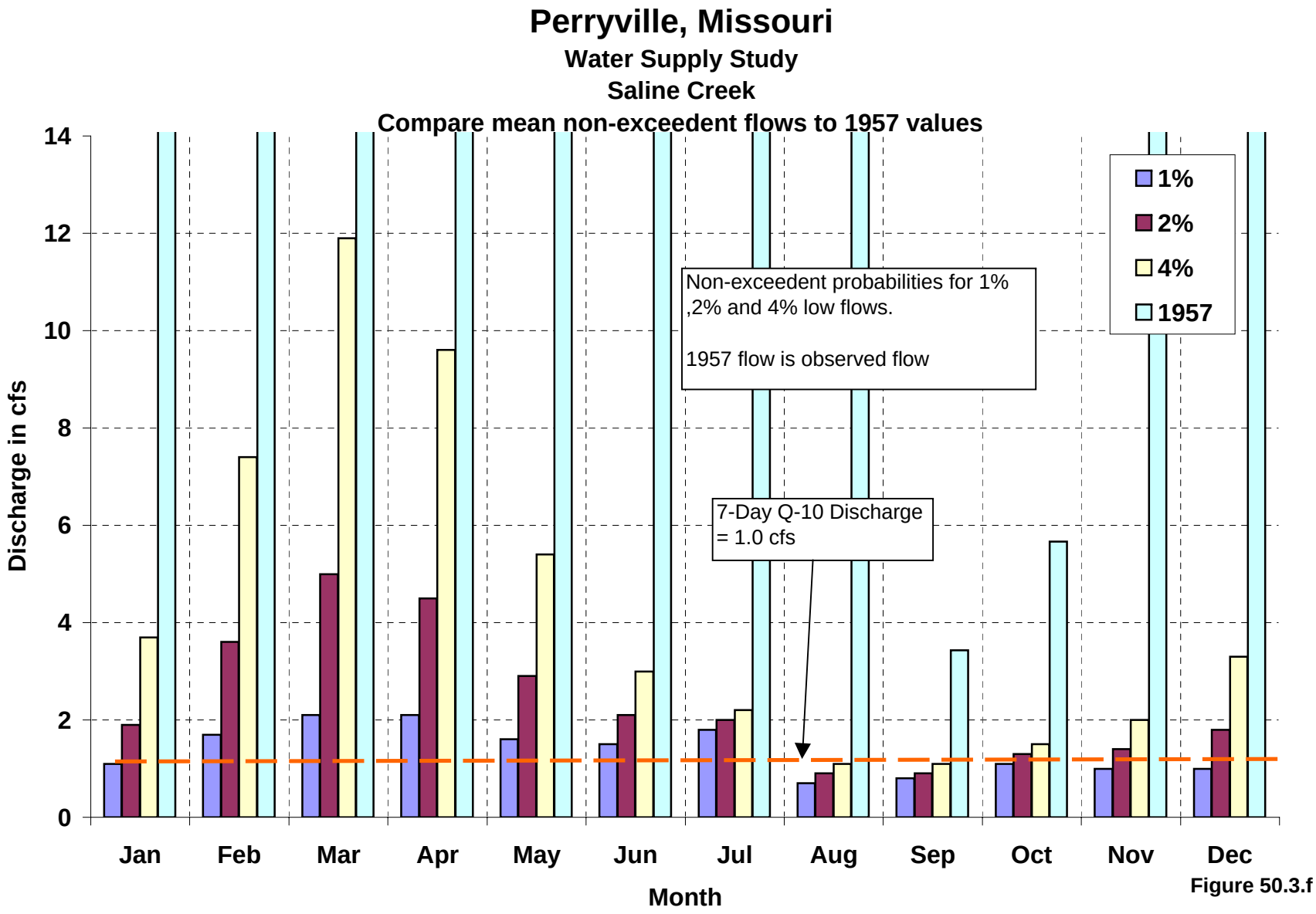

Perryville, Missouri
Water Supply Study
Saline Creek
Compare mean non-exceedent flows to 1957 values
Discharge in cfs
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1%
2%
4%
1957
Non-exceedent probabilities for 1% ,2% and 4% low flows.
1957 flow is observed flow
7-Day Q-10 Discharge = 1.0 cfs

Figure 50.3.f

Perryville, Missouri

Water Supply Study
Saline Creek
Base Flow Index

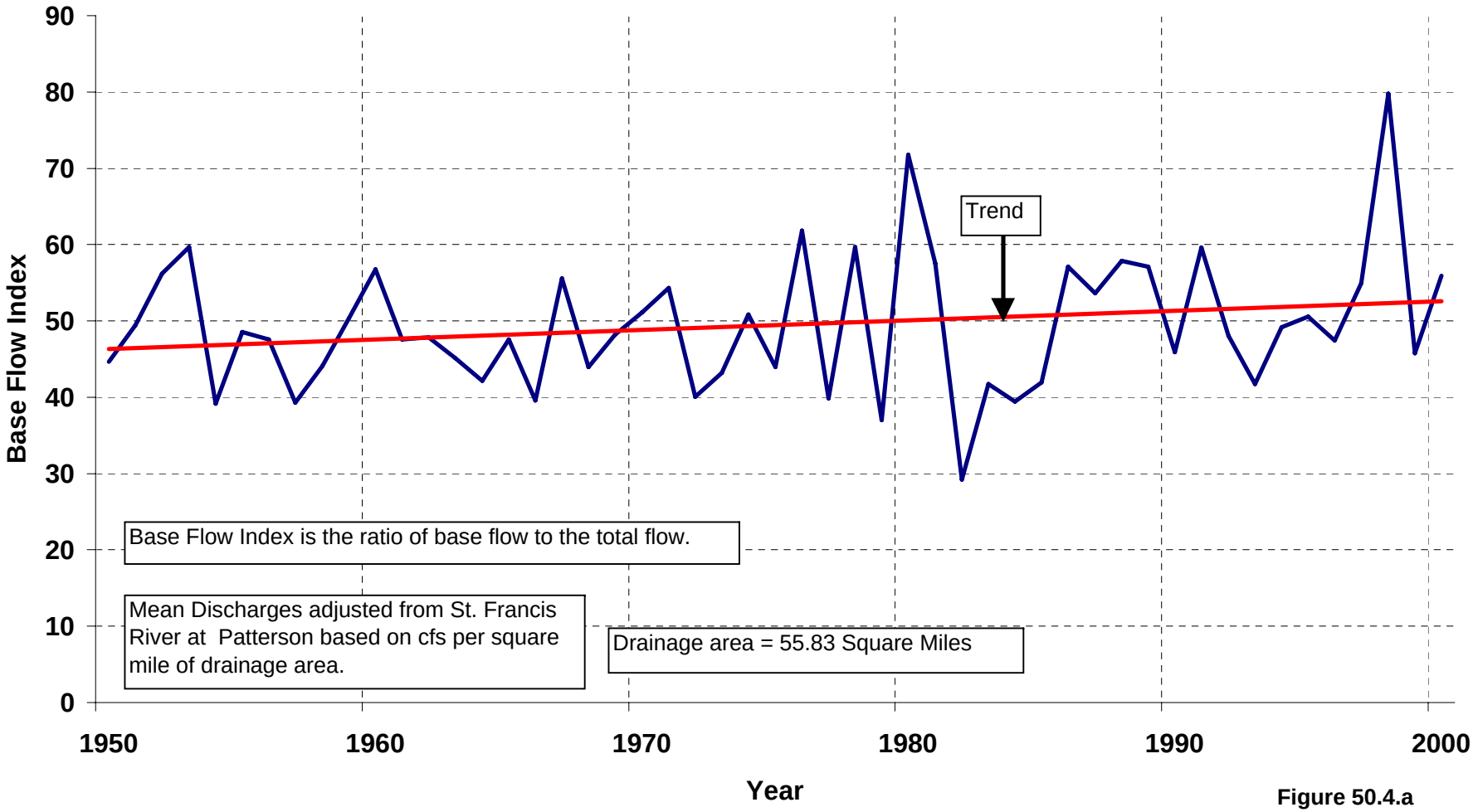


Figure 50.4.a

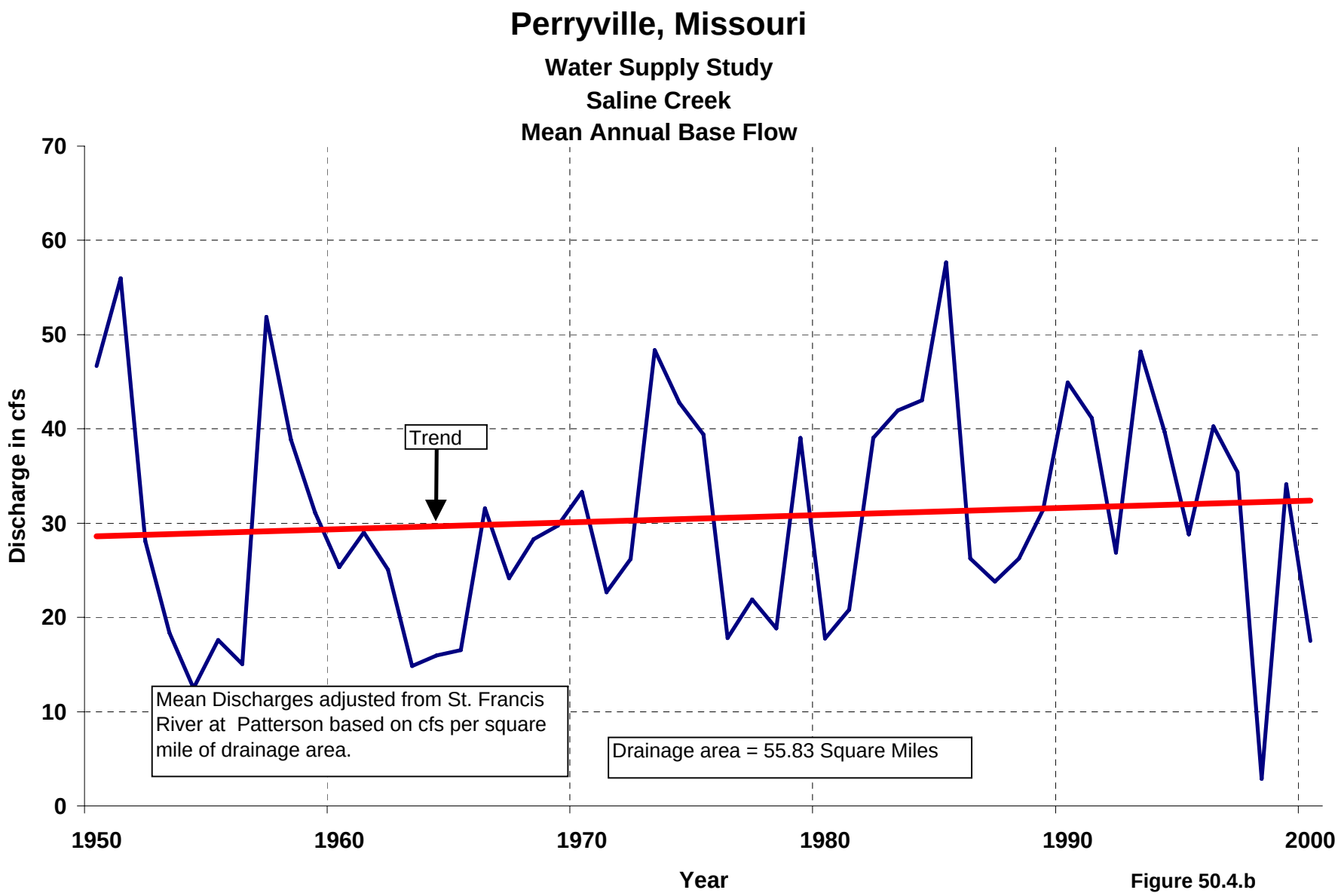

Perryville, Missouri
Water Supply Study
Saline Creek
Mean Annual Base Flow
Discharge in cfs
70
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
2000
Year
Trend
Mean Discharges adjusted from St. Francis River at Patterson based on cfs per square mile of drainage area.
Drainage area = 55.83 Square Miles

Figure 50.4.b

Perryville, Missouri

Water Supply Study
Saline Creek
Annual Base Flow in Watershed Inches

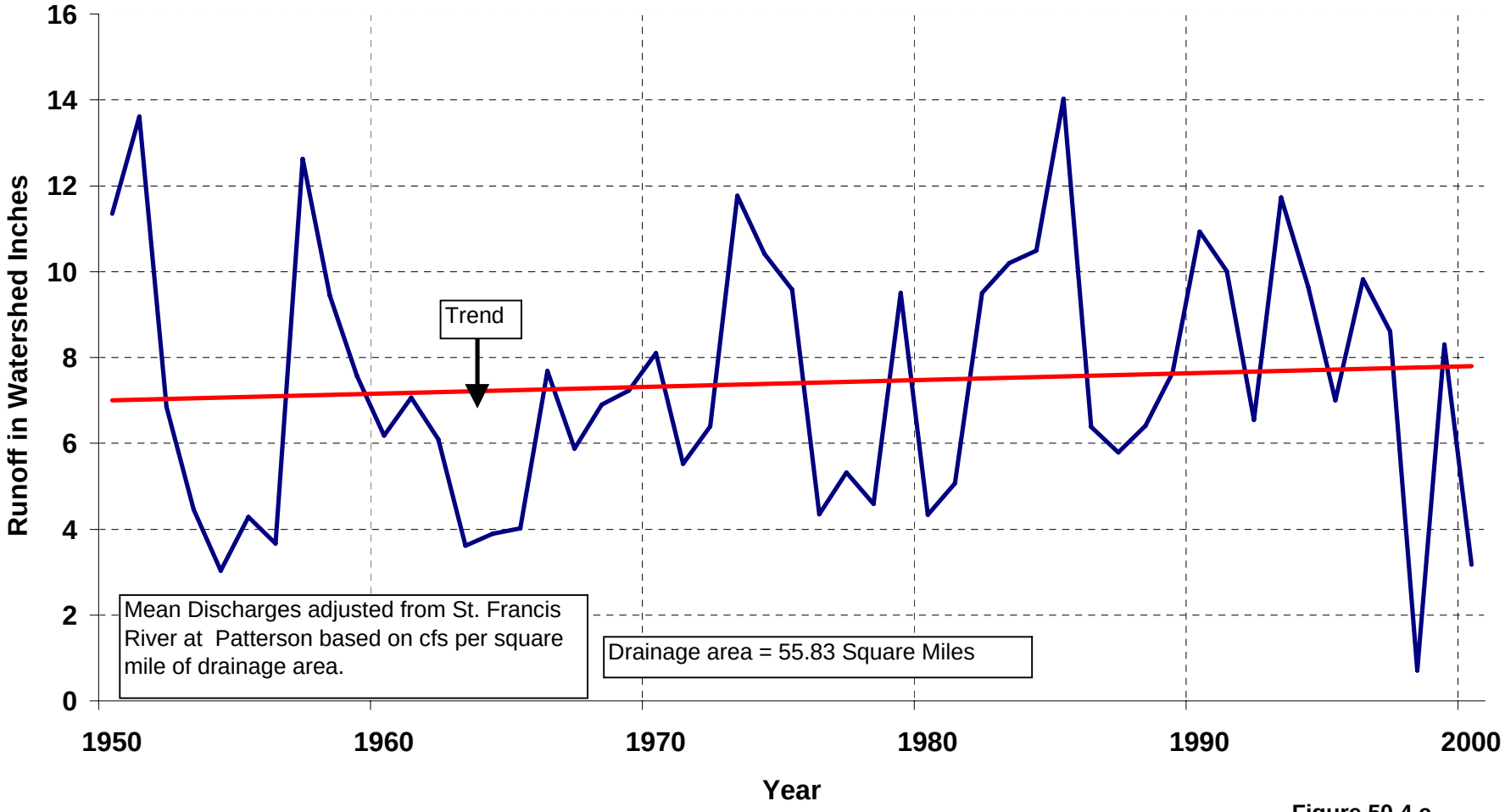


Figure 50.4.c

Perryville, Missouri

Water Supply Study

Compare Mean Annual Discharge per Square Mile Drainage Area

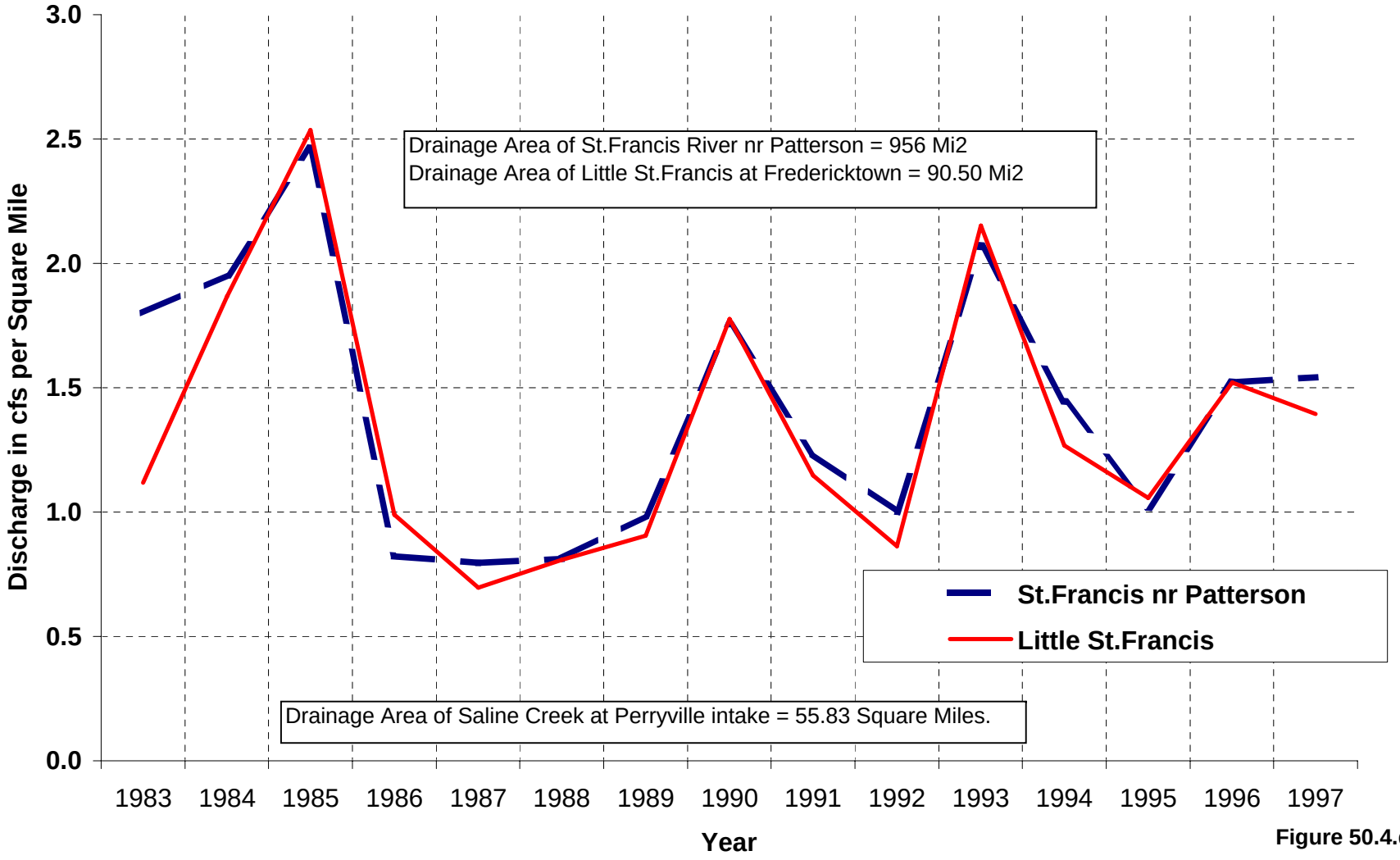


Figure 50.4.d

Perryville, Missouri

Water Supply Study

Saline Creek

Mean Discharge per Square Mile Drainage Area

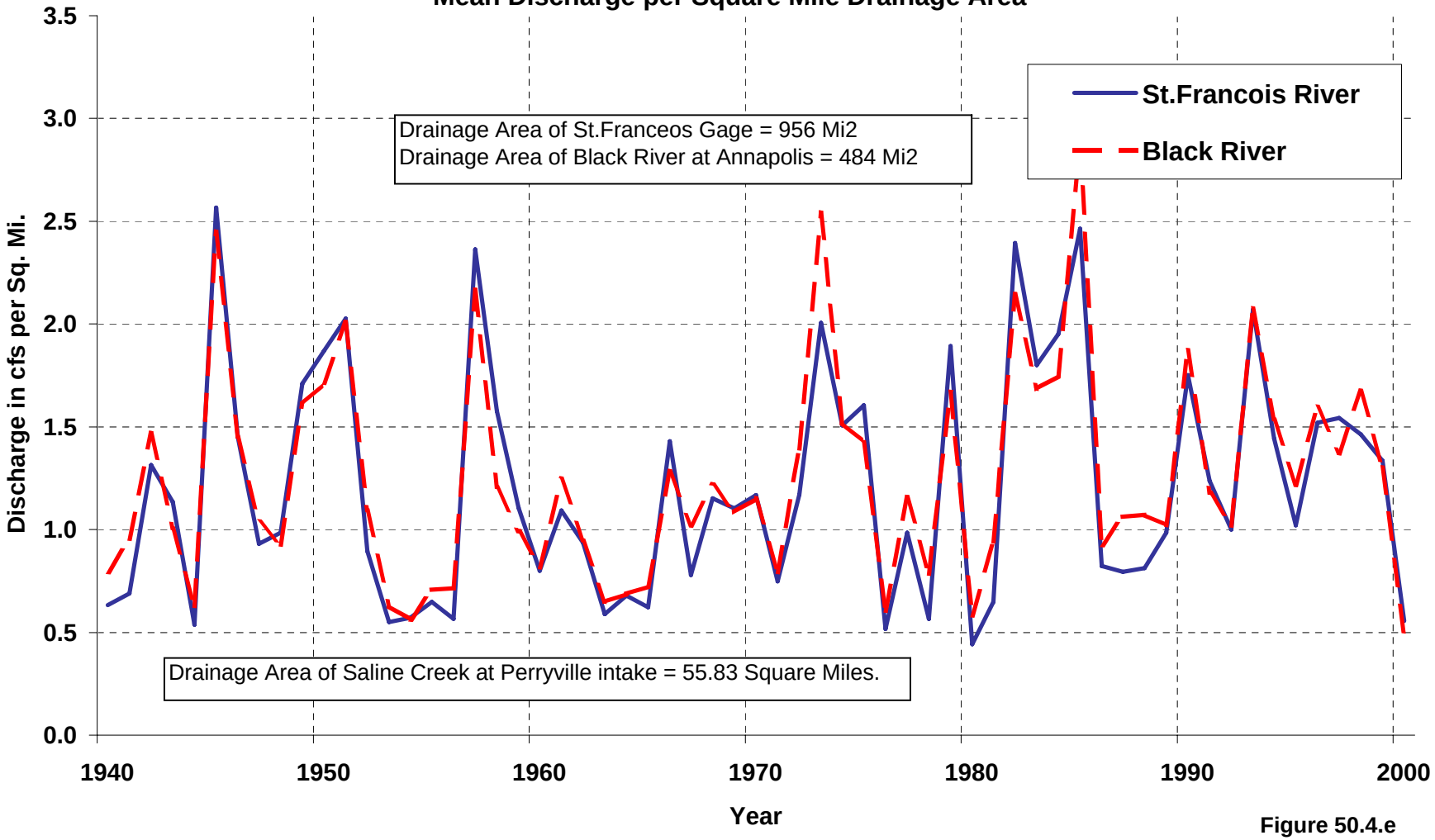


Figure 50.4.e

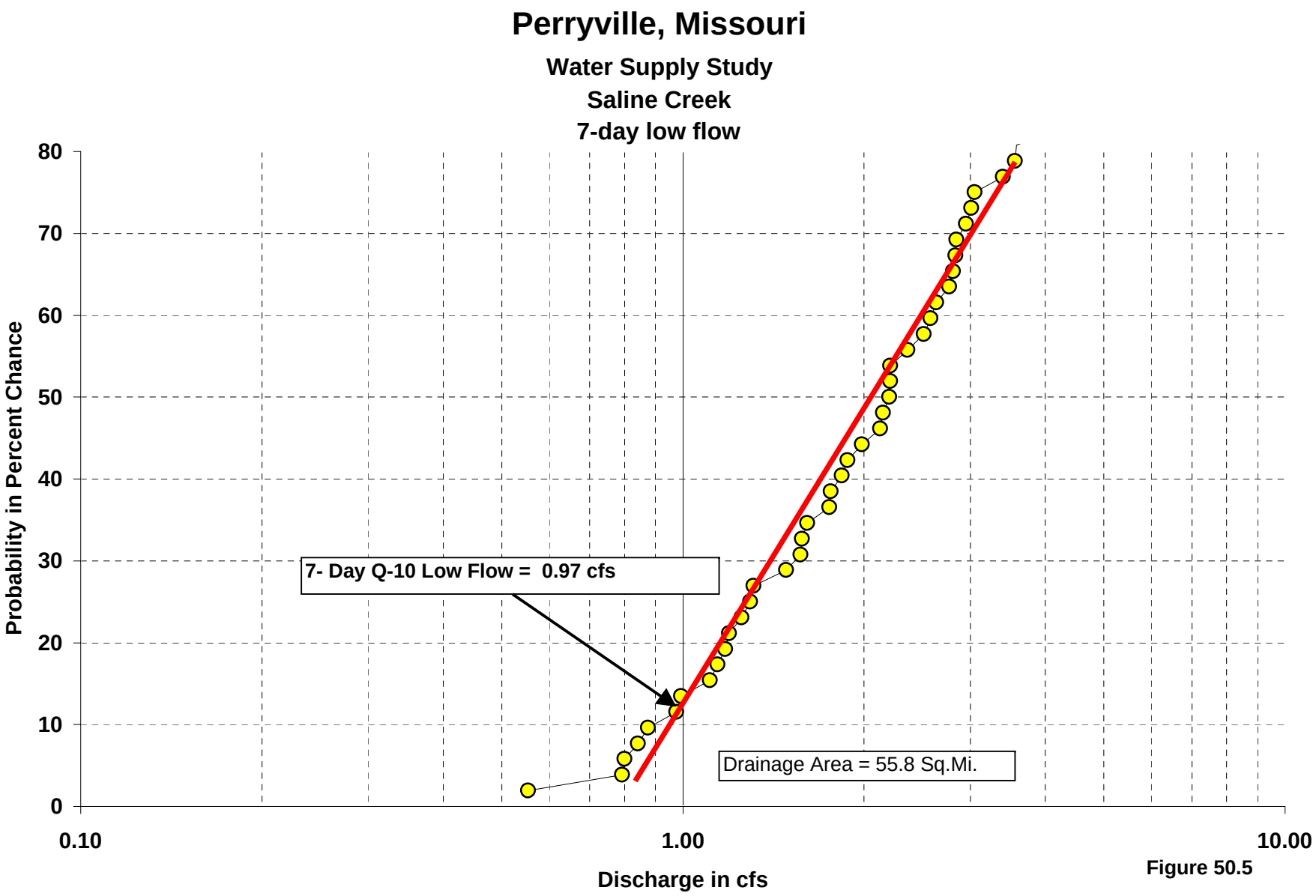

Perryville, Missouri
Water Supply Study
Saline Creek
7-day low flow
Probability in Percent Chance
80
70
60
50
40
30
20
10
0
0.10
1.00
10.00
Discharge in cfs
7- Day Q-10 Low Flow = 0.97 cfs
Drainage Area = 55.8 Sq.Mi.

Figure 50.5

Perryville, Missouri

Water Supply Study

Saline Creek

Mean Annual 7-day low flow Discharge

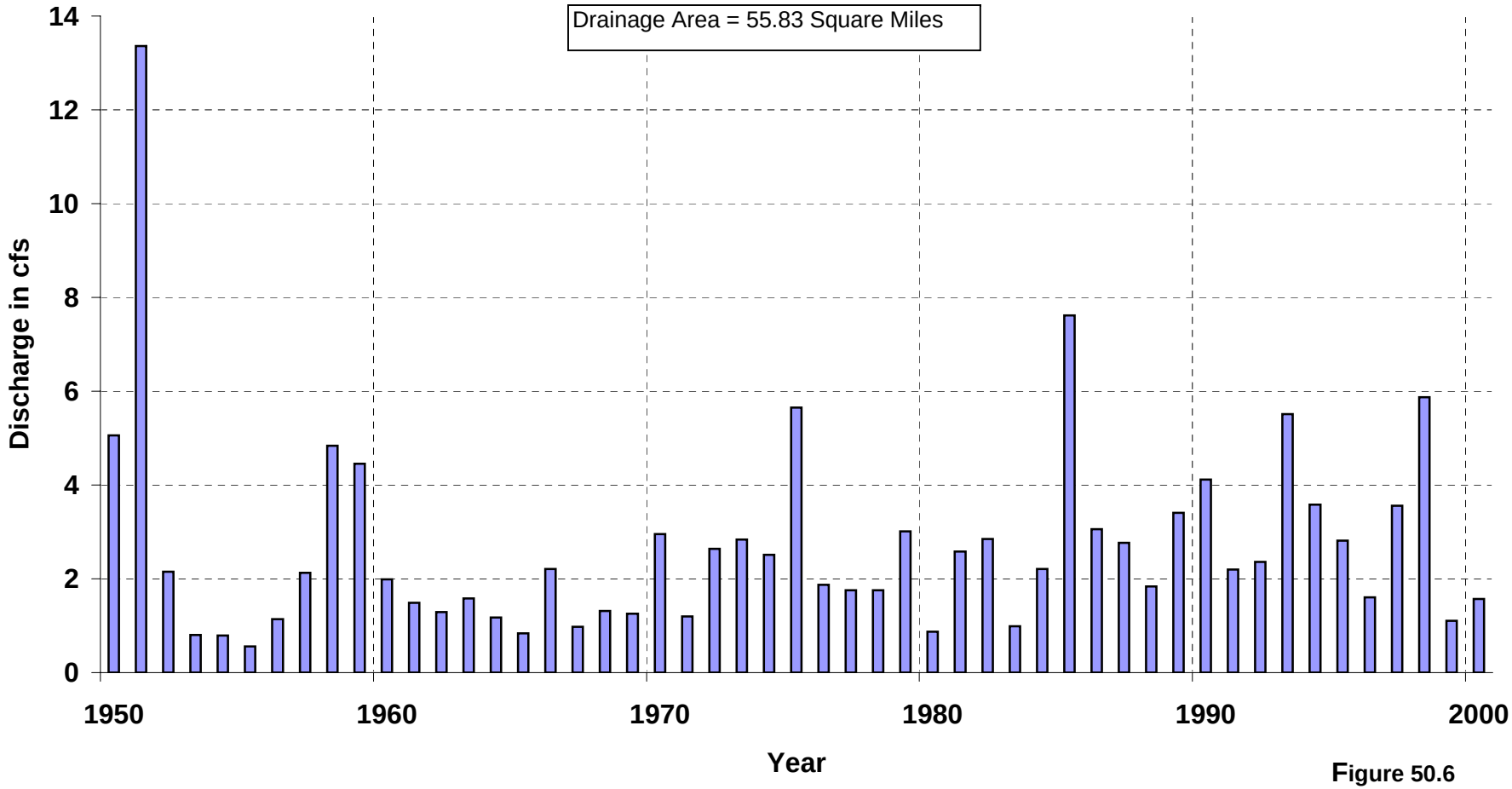


Figure 50.6

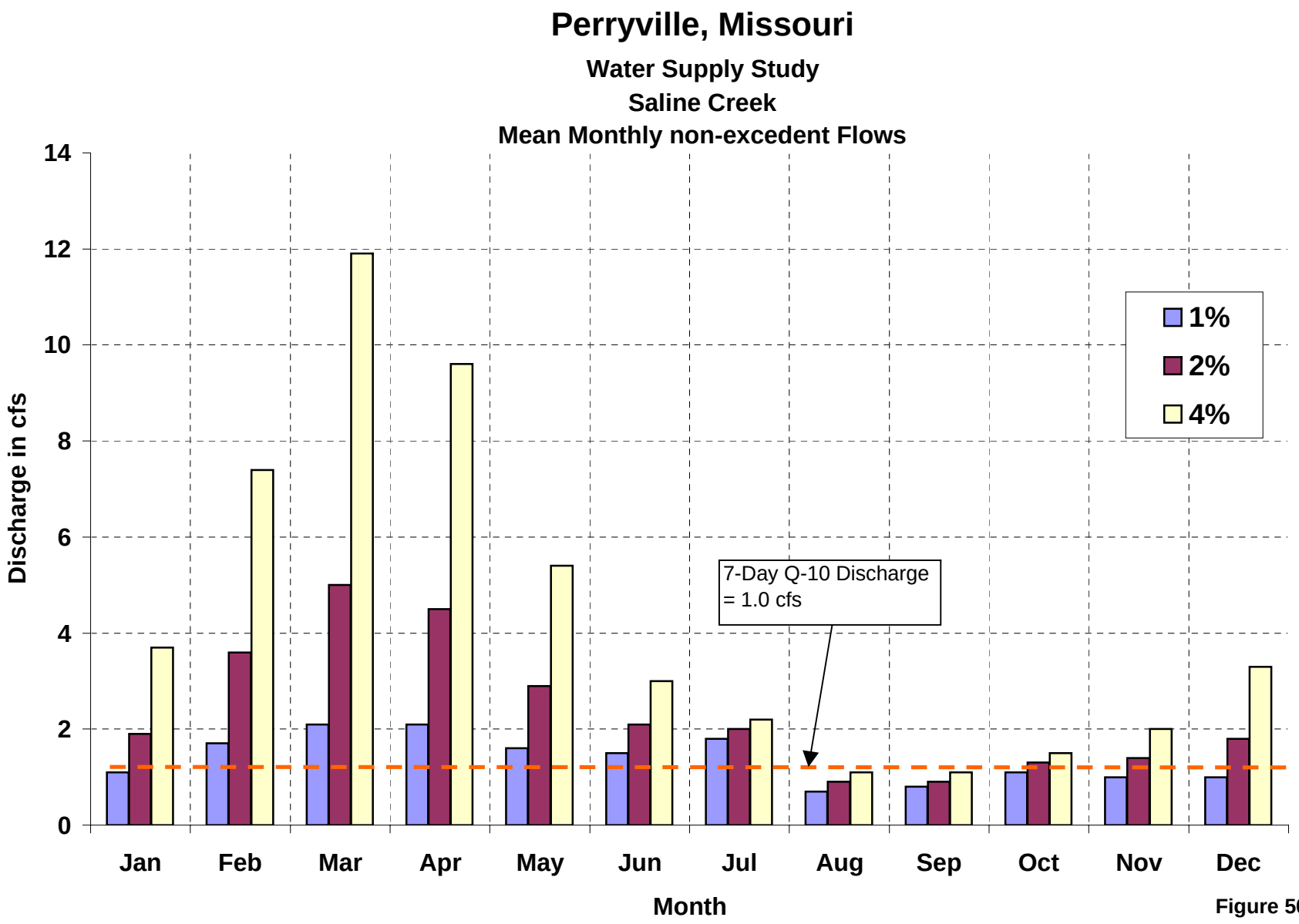

Perryville, Missouri
Water Supply Study
Saline Creek
Mean Monthly non-excedent Flows
Discharge in cfs
14
12
10
8
6
4
2
0
1%
2%
4%
7-Day Q-10 Discharge
= 1.0 cfs
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

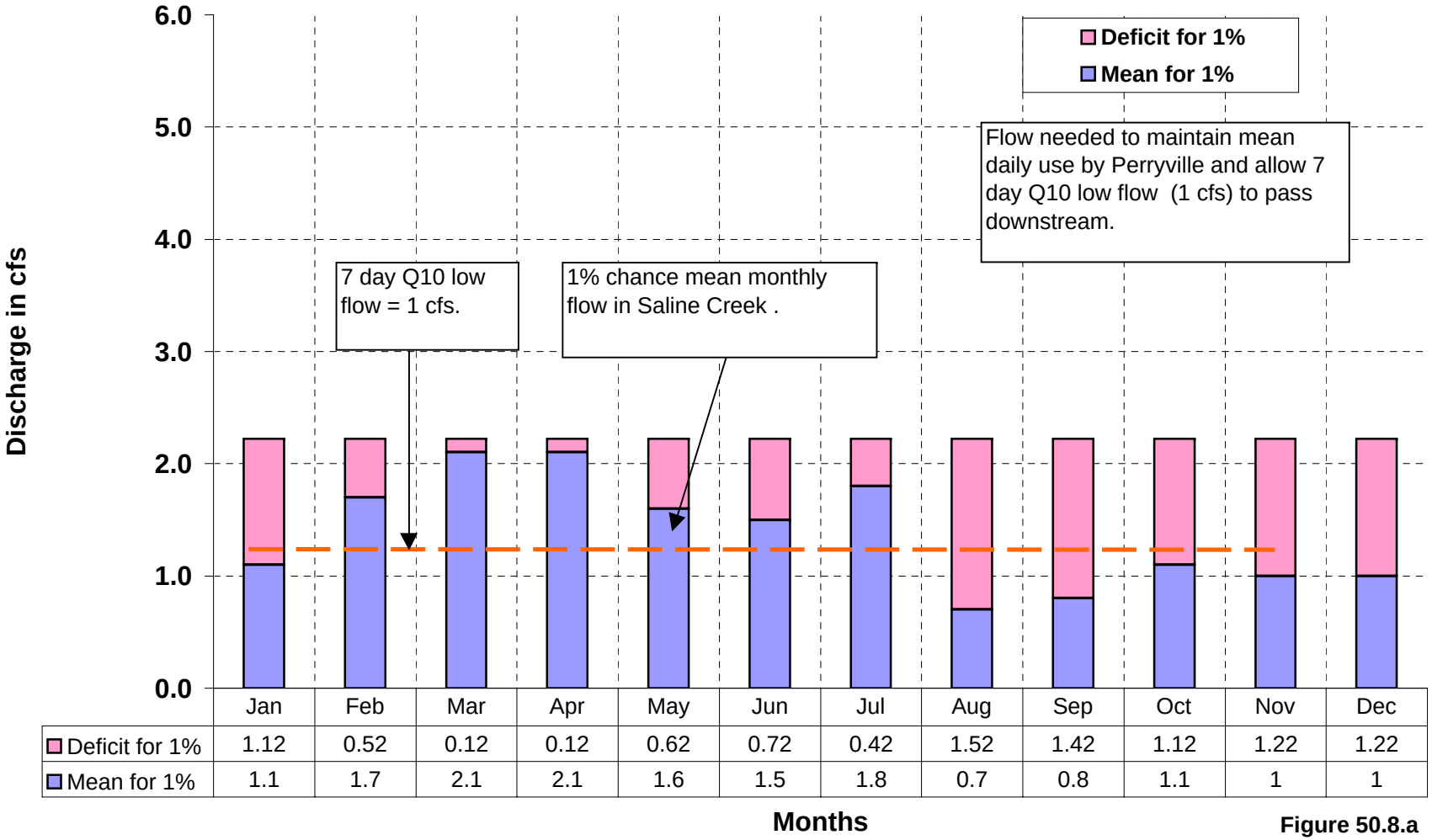
Figure 50.7

Perryville, Missouri

Water Supply Study

Saline Creek

1% Chance non-exceedent flow or 1 year in 100



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deficit for 1%	1.12	0.52	0.12	0.12	0.62	0.72	0.42	1.52	1.42	1.12	1.22	1.22
Mean for 1%	1.1	1.7	2.1	2.1	1.6	1.5	1.8	0.7	0.8	1.1	1	1

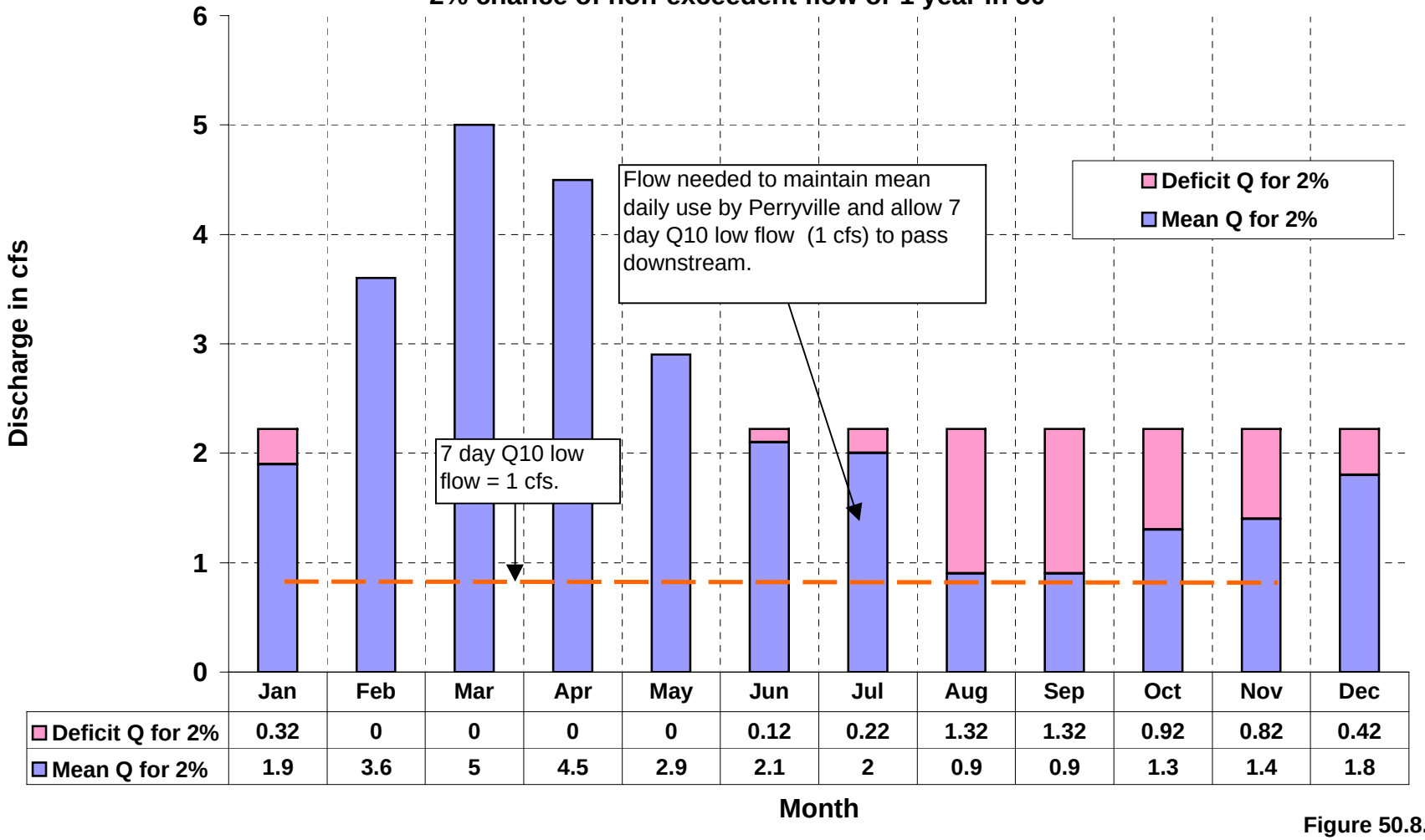
Figure 50.8.a

Perryville, Missouri

Water Supply Study

Saline Creek

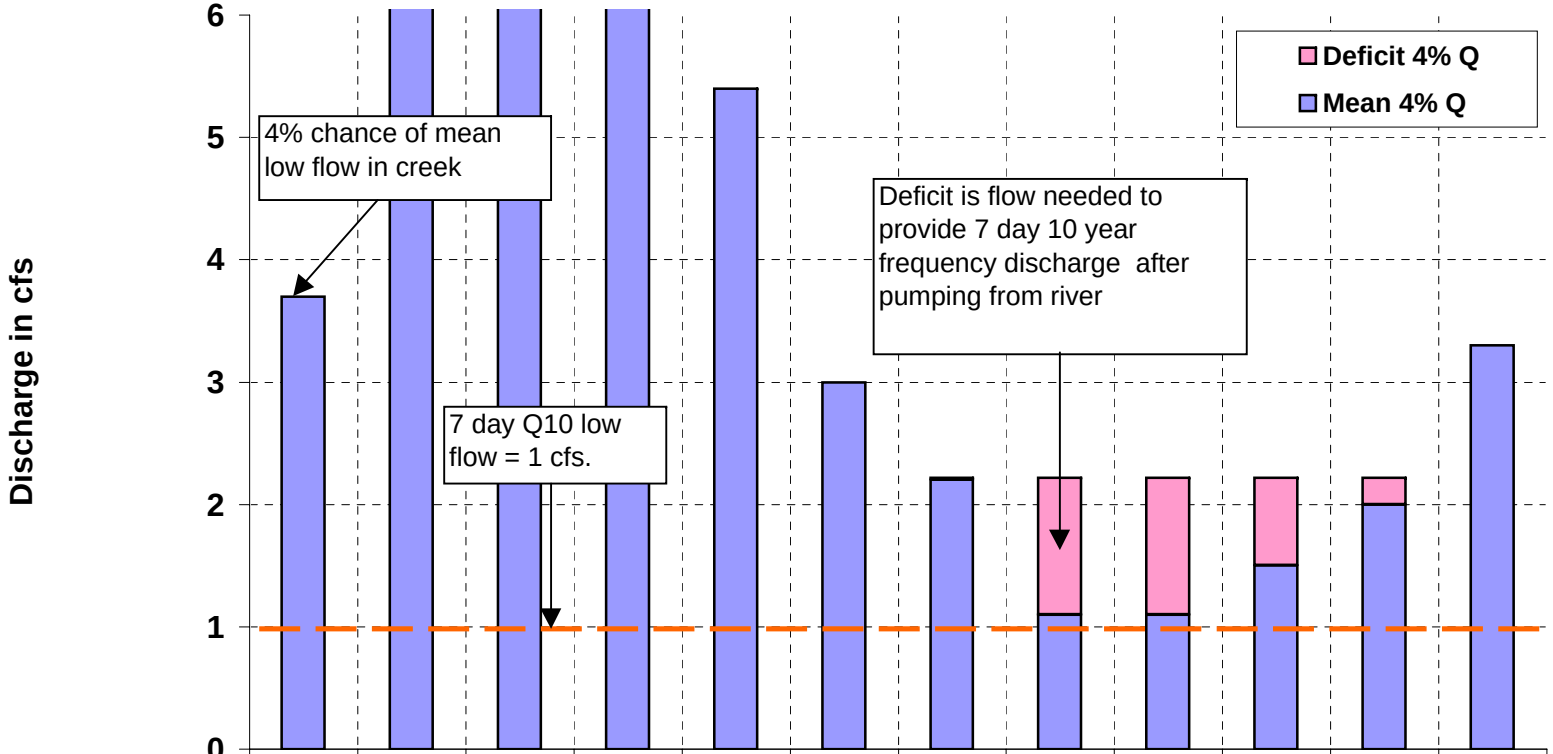
2% chance of non-exceedent flow or 1 year in 50



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deficit Q for 2%	0.32	0	0	0	0	0.12	0.22	1.32	1.32	0.92	0.82	0.42
Mean Q for 2%	1.9	3.6	5	4.5	2.9	2.1	2	0.9	0.9	1.3	1.4	1.8

Figure 50.8.b

Perryville, Missouri
Low Flow
4% chance of non-exceedence
or 1 year in 25 years
Period of Record 1950 through 2000



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deficit 4% Q	0	0	0	0	0	0	0.02	1.12	1.12	0.72	0.22	0
Mean 4% Q	3.7	7.4	11.9	9.6	5.4	3	2.2	1.1	1.1	1.5	2	3.3

Figure 50.8.c

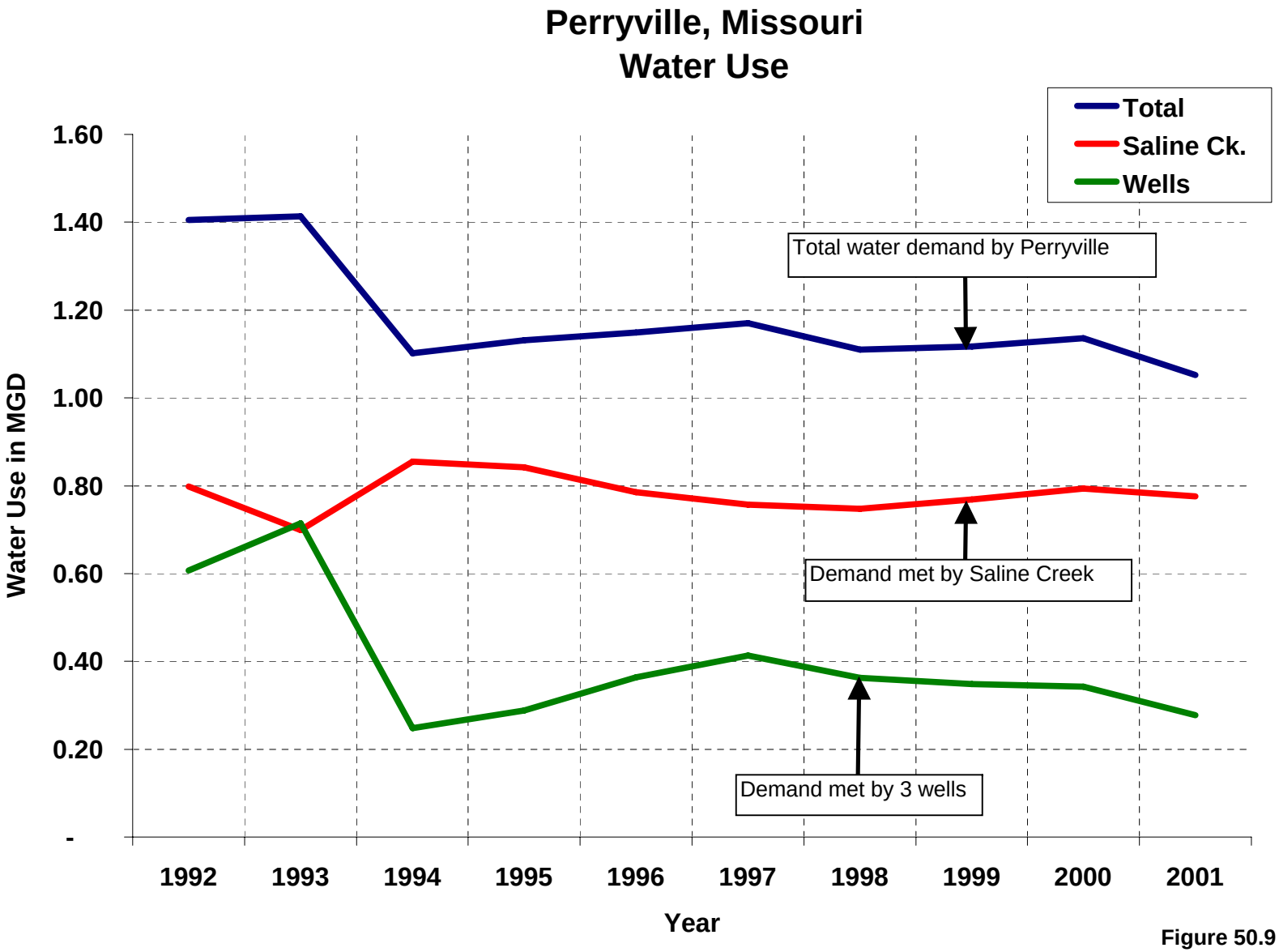
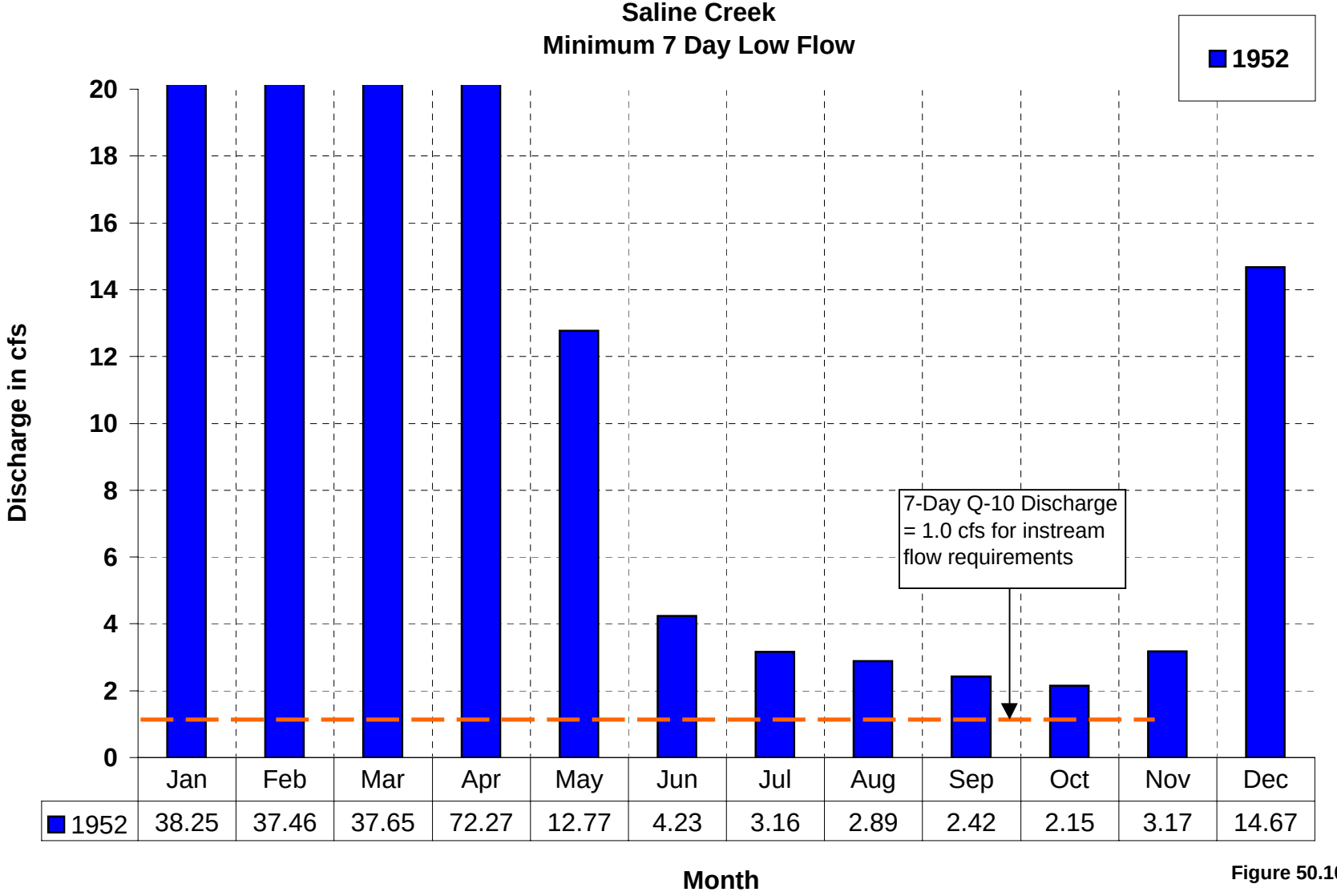

Perryville, Missouri
Water Use
Total
Saline Ck.
Wells
Total water demand by Perryville
Demand met by Saline Creek
Demand met by 3 wells
Water Use in MGD
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
-
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year

Figure 50.9

Perryville, Missouri

Saline Creek

Minimum 7 Day Low Flow



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1952	38.25	37.46	37.65	72.27	12.77	4.23	3.16	2.89	2.42	2.15	3.17	14.67

Figure 50.10.a

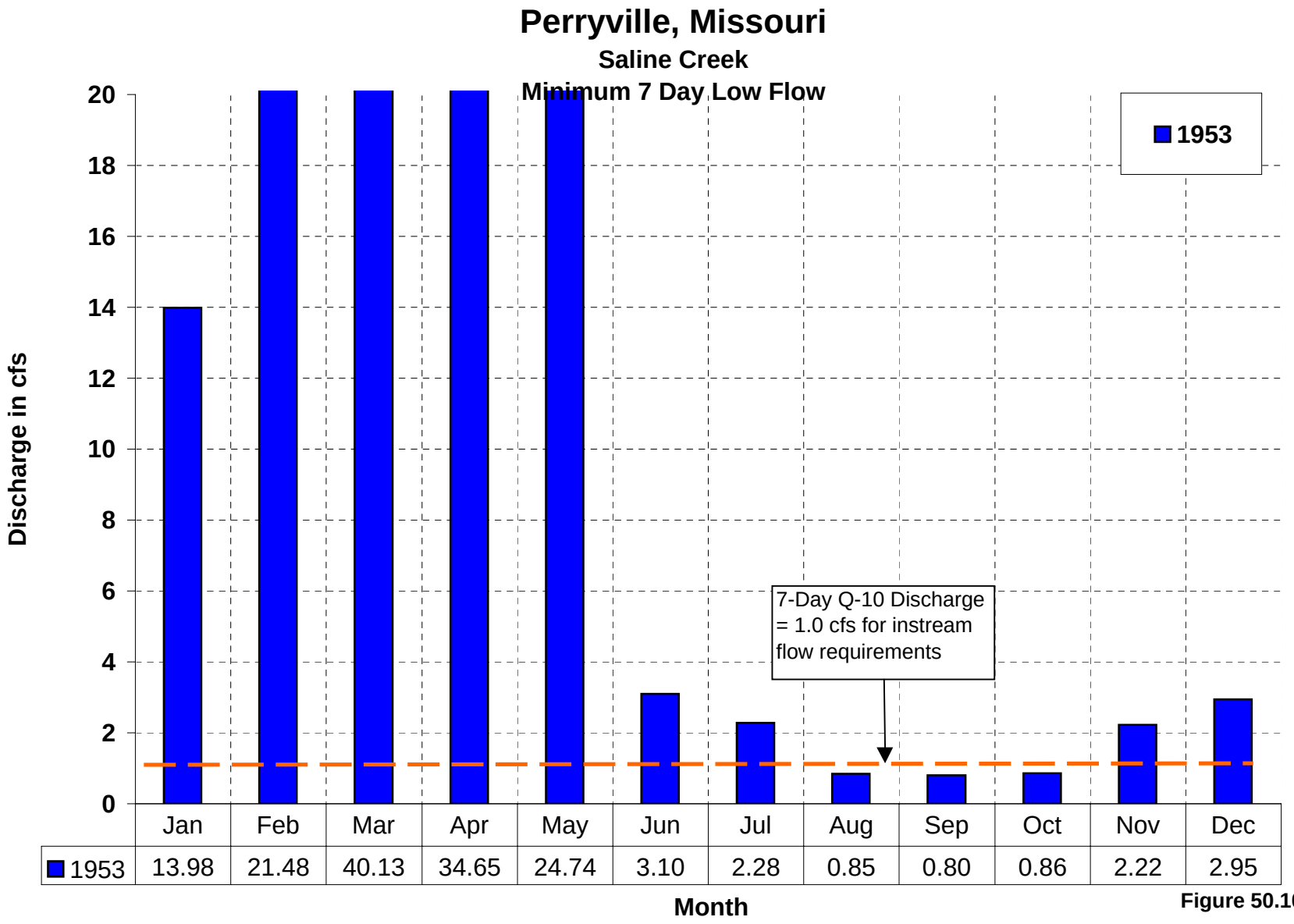


Figure 50.10.b

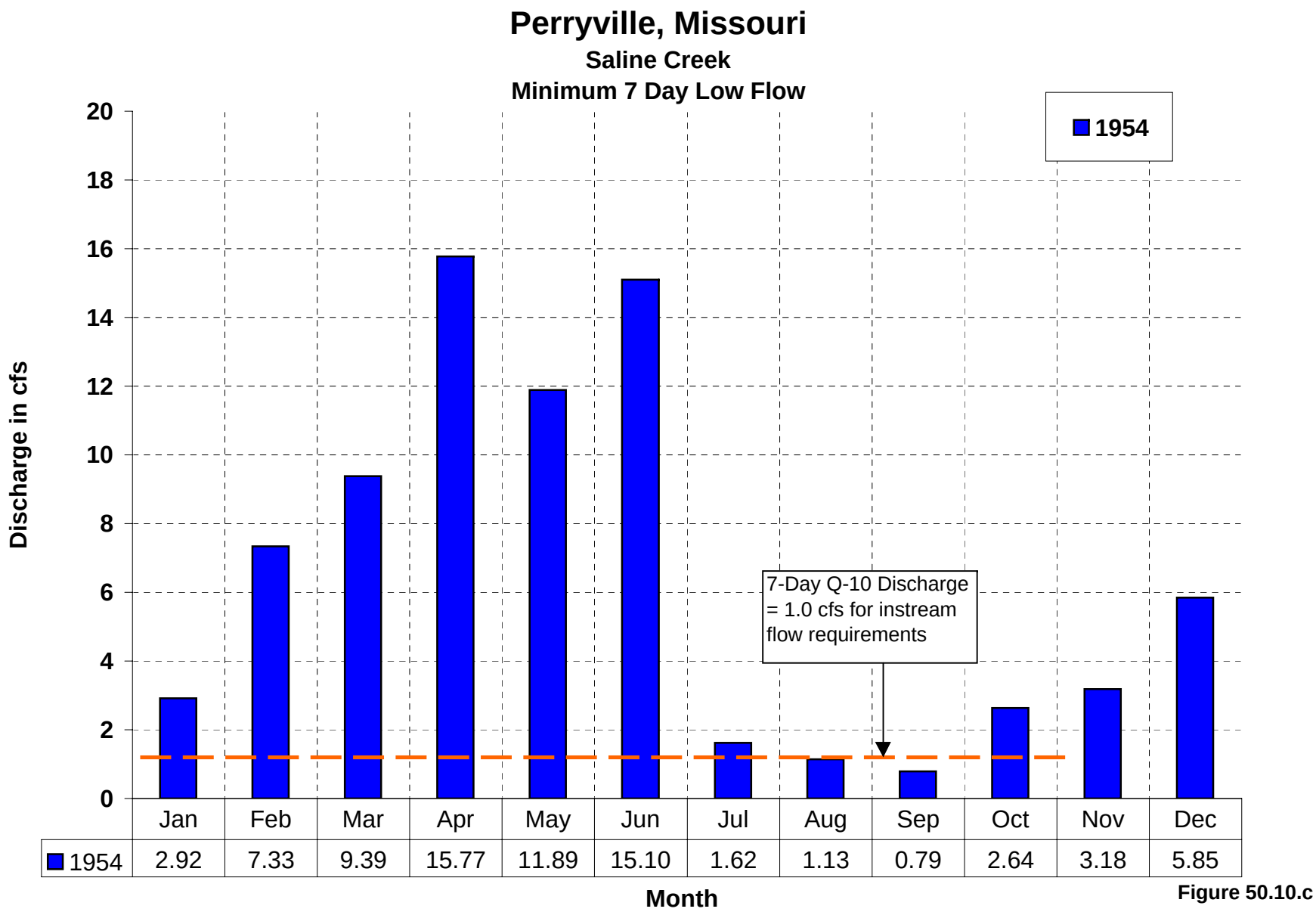
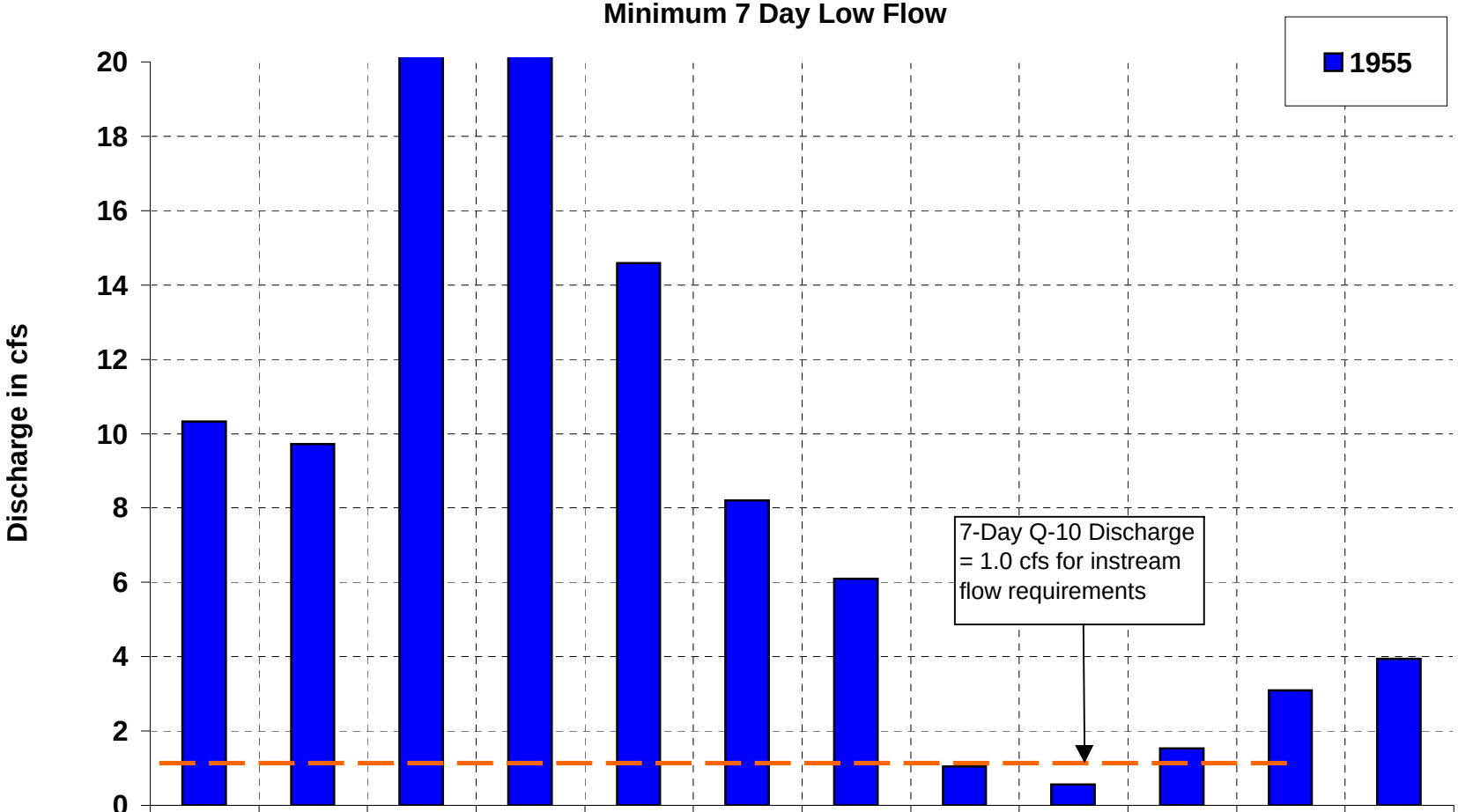


Figure 50.10.c

Perryville, Missouri

Saline Creek

Minimum 7 Day Low Flow



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1955	10.32	9.72	47.85	20.46	14.59	8.21	6.10	1.04	0.55	1.54	3.09	3.94

Month

Figure 50.10.d

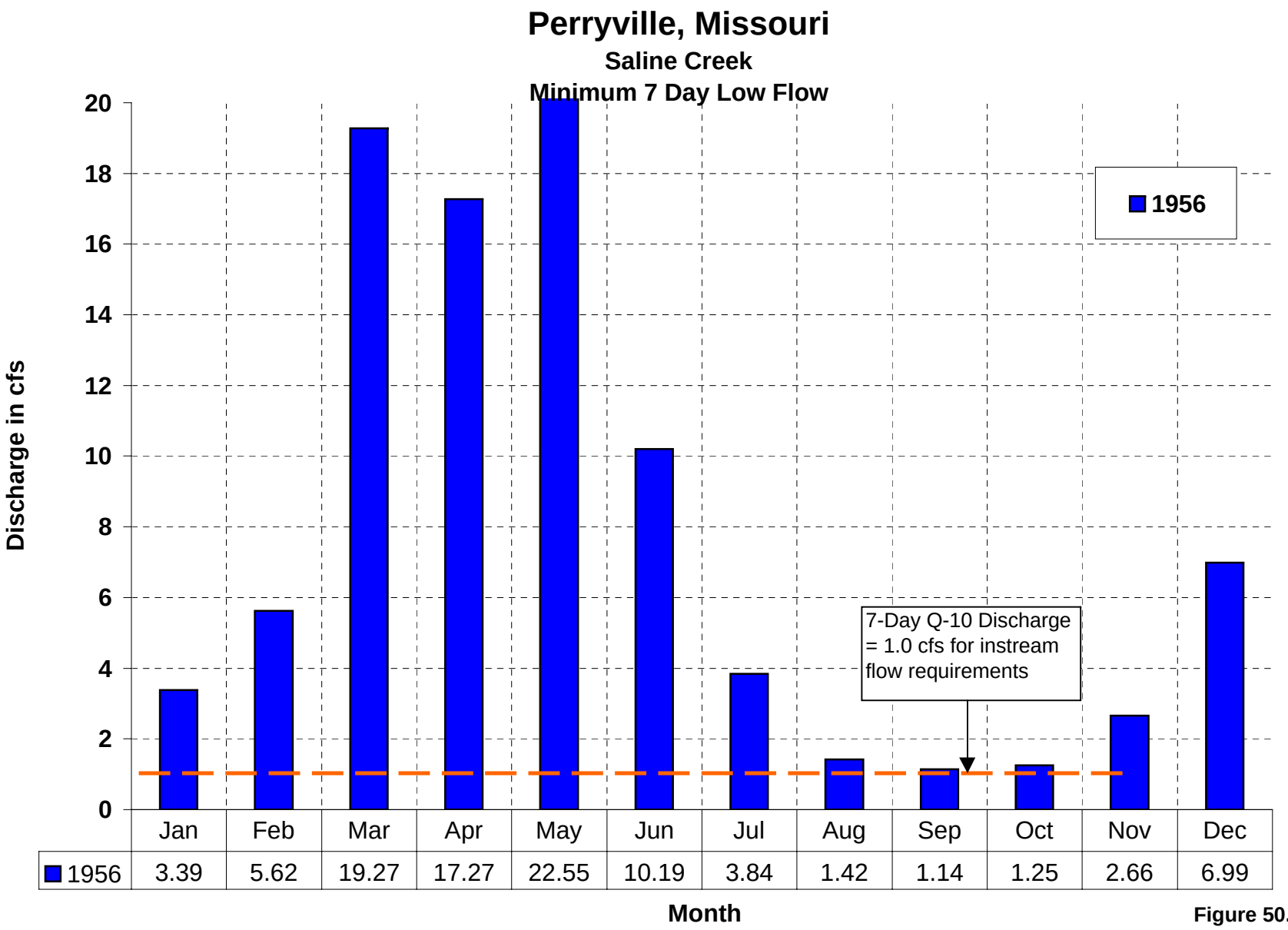


Figure 50.10.e

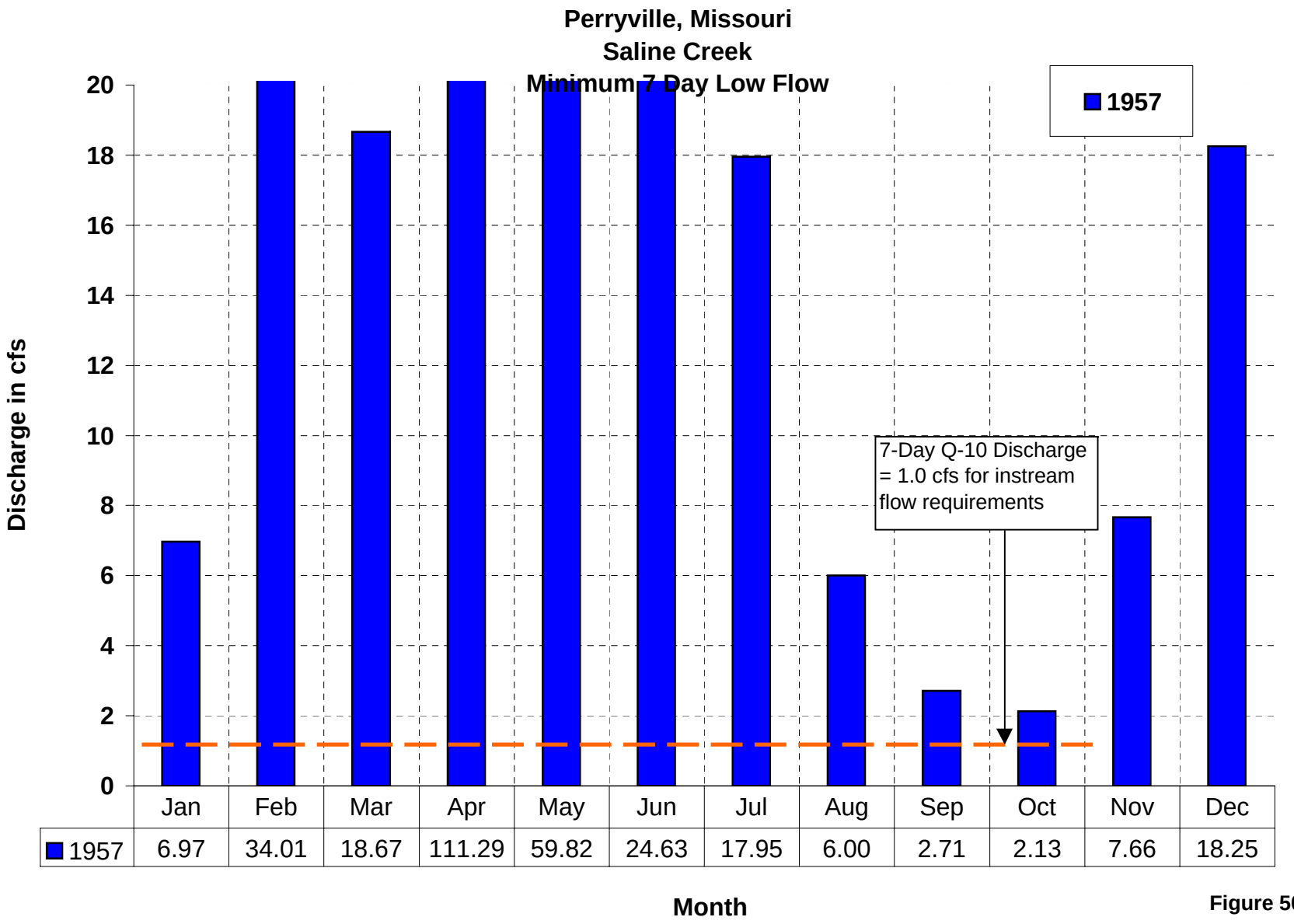


Figure 50.10.f